DOCUMENT RESUME

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TITLE	Environmental Support Specialist, Blocks VI & VII, 17-7. Military Curriculum Materials for Vocational and Technical Education.
INSTITUTION	Air Force Training Command, Sheppard AFB, Tex.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	78
NOTE	358p.; For related documents see CE 034 965-967.
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	*Environmental Technicians; *Equipment Maintenance; Equipment Utilization; Guidelines; Lesson Plans; Military Personnel; Military Training; Postsecondary Education; Public Health; Sanitation; *Solid Wastes; *Technical Education; Transportation; *Waste Disposal; *Waste Water; Water Treatment; Workbooks
IDENTIFIERS	Military Curriculum Project

ABSTRACT

This military-developed text contains the final section of a four-part course to train environmental support specialists. Covered in the individual course blocks are maintenance of water and waste processing system components (external corrosion control, cathodic protection, drive equipment, pipelines and valves, meters and recorders, chemical feeders, maintenance of sewage plant equipment, pump maintenance, and wells and well maintenance) and collection, transportation, and disposal of solid waste (solid waste processing, duties of solid waste monitors, solid waste collection planning and procedures, solid waste transportation, solid waste disposal methods and their operation, sanitation in solid waste processing, public health, and nuisance aspects). This section contains both teacher and student materials. Printed instructor materials include lesson plans with an outline of teaching steps and a plan of instruction detailing the units of instruction, the duration of the lesson, objectives, and supportive materials needed. Among the student materials provided are two study guides containing objectives, assignments, text readings, and review questions as well as two student workbooks containing exercises and lab work. (MN)

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
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FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL

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The National Center for Research in Vocational Education
The Ohio State University
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Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION

Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
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100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
Robert Patton
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1515 West Sixth Ave.
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WESTERN
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1776 University Ave.
Honolulu, HI 96822
808/948-7834

ENVIRONMENTAL SUPPORT SPECIALIST, BLOCKS VI & VII

Classroom Course 17-7 /

Developed by:

United States Air Force

Development and Review Dates:

September 25, 1975

D.O.T. No.:

168.168

Occupational Area:

Public Service

Target Audiences:

Grades 13-adult

Print Pages:

337

Cost:

Availability:

Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Contents:	Type of Materials:	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Instructional Design:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Type of Instruction:	Group Instruction:	Individualized:	
				No. of pages												
Block VI – *Maintenance of Water and Waste Processing System Components*		●		30		●	★		●		●	★		●		
Block VII – *Collection, Transportation, and Disposal of Solid Waste*		●		13		●	★		●		●	★		●		

★ Materials are recommended but not provided.

THE CENTER FOR VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

Expires July 1, 1978

Course Description:

This is the last section of a four-part course to train environmental support specialists. The course includes training in water treatment plants, operating procedures for solid waste disposal, and maintenance of water and waste processing system components. The previous sections dealt with waste processing, water analysis, water treatment, and waste disposal. This section discusses maintenance of processing system components, and the collection, transportation and disposal of solid waste. It contains two blocks of instruction covering 96 hours.

Block VI — *Maintenance of Water and Waste Processing System Components* contains eight lessons covering 70 hours of instruction. A ninth lesson on logs and reports was deleted because it used military forms. The lesson topics and respective hours follow:

External Corrosion Control (3 hours)
Cathodic Protection (3 hours)
Drive Equipment and Accessories (10 hours)
Pipelines, Valves, Meters, and Recorders (8 hours)
Chemical Feeders (8 hours)
Maintenance of Sewage Plant Equipment (8 hours)
Pump Maintenance (22 hours)
Wells and Well Maintenance (8 hours)

Block VII — *Collection, Transportation and Disposal of Solid Waste* contains seven lessons covering 26 hours of instruction. An eighth lesson on logs and reports was deleted.

Introduction to Solid Waste Processing (2 hours)
Duties of Solid Waste Monitor (1 hour)
Solid Waste Collection Planning and Procedures (6 hours)
Solid Waste Collection and Transportation (3 hours)
Solid Waste Disposal Methods and Their Operation (12 hours)
Sanitation in Solid Waste Processing (1 hour)
Public Health and Nuisance Aspects (1 hour)

This section contains both teacher and student materials. Printed instructor materials include lesson plans with an outline of teaching steps and a plan of instruction detailing the units of instruction, the duration of the lesson, objectives, and support materials needed. Student materials include two study guides containing objectives, assignments, text readings, and review questions and two workbooks containing exercises and lab work.

Several military technical manuals and commercially produced texts are also referenced but are not provided. Audiovisuals recommended for the entire four sections but not provided include twenty films, three slide sets, and one schematic diagram. This section should be preceded by **Environmental Support Specialist, Blocks I–V** (17-4), (17-5), and (17-6). It can be presented in a large group instructional setting or adapted for individualized study in waste treatment or ecology courses.

ENVIRONMENTAL SUPPORT SPECIALIST, BLOCKS VI & VII

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Block VII - Collection, Transportation, And Disposal Of Solid Waste

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Collection, Transportation, And Disposal Of Solid Waste - Study Guides Page 311

Collection, Transportation, And Disposal Of Solid Waste - Workbooks Page 323

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PLAN OF INSTRUCTION	COURSE TITLE Environmental Support Specialist
BLOCK TITLE Maintenance of Water and Waste Processing System Components	

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
1. External Corrosion Control	3 (2/1) Day 46	**Column 1 Reference** — **STS Reference** 1a — 7k 1b — 7k
a. Following written instructions, define corrosion, list factors for corrosion to occur, list types of corrosion, and methods of prevention.	(1.5/1)	**Instructional Materials** SG 3ABR56330-VI-1, External Corrosion Control WB 3ABR56330-VI-1-P1, Introduction to Corrosion Control **Audio Visual Aids** TF 5568, Corrosion in Aerospace Weapons Systems SAFB 58, Corrosion (Steel Horizons)
b. Given samples of metals, determine kinds of corrosion on the metals and their prevention.	(0.5/0)	**Training Methods** Discussion (1.5 hrs) Performance (0.5 hr) Outside Assignment (1 hr) **Instructional Environment/Design** Classroom (1.5 hrs) Laboratory (0.5 hr) Study Hall (1 hr) Group/Lockstep **Instructional Guidance** Discuss the methods of removing corrosion and how to treat ferrous, stainless steel, and copper metals. Discuss and present film.
2. Cathodic Protection	3 (2/1) Day 46	**Column 1 Reference** — **STS Reference** 2a — 7m 2b — 7m
a. Identify methods of cathodic protection, list the equipment protected by cathodic methods.	(1/0.5)	

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PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
b. List the installation procedures for cathodic protection, and the safety precautions to observe when working with cathodic protection systems.	(1/0.5)	Instructional Materials SG 3ABR56330-VI-2, Cathodic Protection WB 3ABR56330-VI-2-P1, Cathodic Protection Audio Visual Aids TF 6142, Public Works and Public Utilities Training Equipment Cathodically Protected Pipeline (12) Multimeter (6) Training Methods Discussion (1 hr) Performance (1 hr) Outside Assignment (1 hr) Instructional Environment/Design Classroom (1 hr) Laboratory (1 hr) Study Hall (1 hr) Group/Lockstep Instructional Guidance Discuss and demonstrate the methods of providing cathodic protection to fire protection distribution systems and other components. Check cathodically protected pipeline system.
3. Drive Equipment and Accessories	10 (8/2) Days 46 and 47	Column 1 Reference — STS Reference 3a — 6a, 7f(1), 7f(2) 3b — 3c, 7f(3) 3c — 3c, 7i, 7i
a. Following written instructions, inspect start, operate, and shut down gasoline engine-driven water pump and portable generator.	(2/0)	Instructional Materials SG 3ABR56330-VI-3, Drive Equipment and Accessories WB 3ABR56330-VI-3-P1, Drive Equipment and Accessories WB 3ABR56330-VI-3-P2, Operating a Gasoline Engine AFM 85-13, Maintenance and Operation of Water Plants and Systems

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
b. Using AFM 85-13 as a guide, perform an inspection of an electric motor and correct minor discrepancies.	(1/0)	**Training Equipment** Electric Motor (4) Gasoline Engine (12) Drive Equipment (12) **Training Methods** Discussion (2 hrs) Demonstration (1 hr) Performance (5 hrs) Outside Assignment (2 hrs) **Instructional Environment/Design** Classroom (2 hrs) Laboratory (6 hrs) Study Hall (2 hrs) Group/Lockstep **Instructional Guidance** Demonstrate how to start and operate the gasoline engine and observe safety around all moving machinery. Insure that water pumps are primed before starting engine. Check outside assignments daily: Day 46, read SG VI-1 thru 3, and answer questions on pages 15, 16, and 20; Day 47, answer questions on page 33.
c. Following written instructions, inspect equipment having belts, chains, and variable speed drives; couplings; and shearpins. Report major maintenance to responsible organizations.	(5/2)	
4. Pipelines, Valves, Meters, and Recorders a. Using the pipeline trainer and following written instructions, stop a water leak by installing a compression coupling and calculate the chemicals required, within ± 1 ounce, to sterilize the repaired extension.	8 (6/2) Day 48 (1.5/0.5)	**Column 1 Reference** **STS Reference** 4a 7g(8), 7g(9), 7j 4b 7g(6), 7g(7) 4c 7g(10) 4d 7h 4e 7f(4) 4f 11g(2)

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
b. Using related information, identify procedures for locating buried pipelines, valves, and underground water leaks.	(1/0.5)	Instructional Materials SG 3ABR56330-VI-4, Maintenance of Pipelines, Valves, Meters, and Recorders WB 3ABR56330-VI-4-P1, Maintenance of Pipelines, Valves, Meters, and Recorders Training Equipment Recorder (12) Gate Valve (1) Globe Valve (1) Water Meter (1) Pipeline Trainer (4) Training Methods Discussion (2 hrs) Performance (4 hrs) Outside Assignment (2 hrs) Instructional Environment/Design Classroom (2 hrs) Laboratory (4 hrs) Study Hall (2 hrs) Group/Lockstep Instructional Guidance Before starting performance, show the students the proper wrenches to use and stress not to over tighten nuts on pipe clamps. If over tightened, clamps will be distorted and damaged. Check outside assignments daily: Day 48, read SG VI-4, and answer questions on page 51.
c. Using related information, identify procedures for thawing frozen pipelines.	(0.5/0)	
d. Following written instructions, list the methods and procedures for prevention of back siphonage.	(0.5/0)	
e. Following written instructions, disassemble, repack, and assemble a gate valve.	(1.5/0.5)	
f. Following written instructions, inspect flowmeters, change recorder charts, and read water meters within ± 1 unit.	(1/0.5)	

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PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
5. Chemical Feeders	8 (6/2) Day 49	**Column 1 Reference** / **STS Reference** 5a / 7f(5) 5b / 7f(7) **Instructional Materials** SG 3ABR56330-VI-5, Chemical Feeders WB 3ABR56330-VI-5-P1, Chemical Feeders **Training Equipment** Hypochlorinator, Pump, and Motor (6) Fluoridator (6) **Training Methods** Discussion (2 hrs) Performance (4 hrs) Outside Assignment (2 hrs) **Instructional Environment/Design** Classroom (2 hrs) Laboratory (4 hrs) Study Hall (2 hrs) Group/Lockstep **Instructional Guidance** Divide class into two groups for performance and rotate groups as required. Check outside assignments daily: Day 49, read SG VI-5, and answer questions on pages 60 and 61.
a. Following written instructions, disassemble and reassemble a hypochlorinator.	(3/1)	
b. Following written instructions, disassemble and reassemble a fluoridator.	(3/1)	

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PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)
6. Maintenance of Sewage Plant Equipment	8 (6/2) Day 50
a. Using AFM 85-14 and following written instructions, list the maintenance required for grit chambers, shredders, bar screens, and sedimentation tanks.	(1/0.5)
b. Following written instructions, determine the items of inspection and maintenance required for a sewage lift station.	(1/0.5)
c. Using AFM 85-14 and following written instructions, list the maintenance required for digester, trickling filters, separators, and processing equipment.	(1/1)
d. Using base sewage plant (or sewage trainer during bad weather), inspect sewage lift stations, grit chambers, shredders, bar screens, sedimentation tanks, digesters, trickling filters, and processing equipment for required maintenance using class notes as a guide.	(3/0)

3 SUPPORT MATERIALS AND GUIDANCE

Column 1 Reference	STS Reference
6a	3c, 11g(1), 11g(3), 11h(2), 12l
6b	11f
6c	11h(4), 11h(9), 12k
6d	11f, 11g(1), 11g(3), 11h(2), 11h(4), 11h(9) 12k, 12l

Instructional Materials
SG 3ABR56330-VI-6, Maintenance of Sewage Plant Equipment
WB 3ABR56330-VI-6-P1, Maintenance of Sewage Plant Equipment
AFM 85-14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems

Training Equipment
Sewage Trainer (12)

Training Methods
Field Trip (3 hrs)
Discussion (1 hr)
Performance (2 hrs)
Outside Assignment (2 hrs)

Instructional Environment/Design
Field Trip (3 hrs)
Classroom (1 hr)
Laboratory (2 hrs)
Study Hall (2 hrs)
Group/Lockstep

Instructional Guidance
During trip to base sewage plant, have students inspect sewage plant equipment for condition and necessary maintenance. If weather is bad,

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
		use sewage trainer to perform required inspections. Check outside assignments daily: Day 50, read SG VI-6, and answer questions on page 72.
7. Pump Maintenance	22 (16/6) Days 51,52 and 53	Column 1 Reference — STS Reference 7a — 7f(1) 7b — 7f(1), 11e
a. Given conditions of a defective centrifugal pump and a troubleshooting guide, determine and list the required maintenance for the pump.	(6/2)	**Instructional Materials** SG 3ABR56330-VI-7, Pump Maintenance WB 3ABR56330-VI-7-P1, Identification of Pumps and Parts WB 3ABR56330-VI-7-P2, Teardown, Reassembly, and Operation of a Centrifugal Pump
b. Following written instructions, disassemble a centrifugal pump, inspect and replace defective parts, reassemble and connect pump to a drive assembly, and adjust leakage from 3 to 6 drops per minute during operational check.	(10/4)	**Audio Visual Aids** TVS 56-6, Centrifugal Pump Maintenance **Training Equipment** Centrifugal Pump (1) Turbine Pump (12) Axial Flow Pump (12) **Training Methods** Discussion (4 hrs) Performance (12 hrs) Outside Assignments (6 hrs) **Instructional Environment/Design** Classroom (4 hrs) Laboratory (12 hrs) Study Hall (6 hrs) Group/Lockstep

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
		Instructional Guidance Observe students to insure that they are using correct wrenches. Stress hazard to equipment from over tightening nuts and bolts. Insure each student has aligned pump with motor to prevent shaft and coupling damage. If pump has excessive leakage,have students recheck packing. Check outside assignments daily: Day 51, read SG VI-7, Day 52, review SG VI-7.
8. Wells and Well Maintenance	8 (6/2) Days 53 and 54	**Column 1 Reference** — **STS Reference** 8a — 7g(1) 8b — 7g(2), 7g(3), 7g(5) 8c — 7g(1), 7g(4)
a. Following written instructions, identify types of water wells and construction features.	(2/0)	**Instructional Materials** SG 3ABR56330-VI-8, Water Well Maintenance WB 3ABR56330-VI-8-P1, Water Well Maintenance
b. Following written instructions, list the methods and procedures for backwashing a well, cleaning well screens, and prevention of freeze up of wells.	(2/1)	**Training Methods** Discussion (3 hrs) Performance (3 hrs) Outside Assignment (2 hrs)
c. Given operating data and following written instructions, calculate static level, pumping level, and drawdown, and calculate within ± 1 ounce the calcium hypochlorite needed to sterilize a well that contains 1000 gallons of water.	(2/1)	**Instructional Environment/Design** Classroom (3 hrs) Laboratory (3 hrs) Study Hall (2 hrs) Group/Lockstep **Instructional Guidance** Each student will compute problems involving static levels, pumping levels, and drawdown. Day 53, answer questions on page 84 in SG for outside assignment.

PLAN OF INSTRUCTION (Continued)

<table>
<tr><th>1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES</th><th>2 DURATION (HOURS)</th><th>3 SUPPORT MATERIALS AND GUIDANCE</th></tr>
<tr><td>9. Logs and Reports</td><td>6
(6/0)
Days 54
and 55</td><td rowspan="3">
<table>
<tr><th>Column 1 Reference</th><th>STS Reference</th></tr>
<tr><td>9a</td><td>6c, 7l</td></tr>
<tr><td>9b</td><td>6c, 7l, 11n, 12j</td></tr>
</table>

Instructional Materials
SG 3ABR56330-VI-9, Logs and Reports
WB 3ABR56330-VI-9-P1, Logs and Reports
AF Forms 708, 995, 996, 1460, 1461, 1462, 1463
AFM 85-13, Maintenance and Operation of Water Plants and Systems
AFM 85-14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems

Training Methods
Discussion (2 hrs)
Performance (4 hrs)

Instructional Environment/Design
Classroom (2 hrs)
Laboratory (4 hrs)
Group/Lockstep

Instructional Guidance
Issue one of each of the AF forms listed in column 3 to each student. Explain the use of each form and have students make proper entries on each form. Check outside assignments daily. Day 54, read pages 85-99 in SG and answer questions on pages 99 and 100.</td></tr>
<tr><td>a. Using AFM 85-13 and AFM 85-14 and following written instructions, identify the purpose of logs and reports used in water and waste processing.</td><td>(2/0)</td></tr>
<tr><td>b. Using AFM 85-13 and AFM 85-14 as a guide and provided with related information, make the proper entries in the appropriate AF form.</td><td>(4/0)</td></tr>
<tr><td>10. Related Training (as shown in course chart)</td><td>2</td><td></td></tr>
<tr><td>11. Measurement Test and Test Critique</td><td>(2/0)
Day 55</td><td></td></tr>
</table>

PLAN OF INSTRUCTION NO. 3ABR56330	DATE 6 June 1975	BLOCK NO. VI	PAGE NO. 48

PLAN OF INSTRUCTION	COURSE TITLE Environmental Support Specialist

BLOCK TITLE

Collection, Transportation, and Disposal of Solid Waste

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
1. Introduction to Solid Waste Processing	2 (2/0) Day 56	**Column 1 Reference** 1a **STS Reference** 13a, 13b(3), 13c, 13e(6)
a. Given a list of various types of solid waste and three waste classifications (garbage, debris, and rubbish), list each solid waste type under its correct classification.	(2/0)	**Instructional Materials** SG 3ABR56330-VII-1, Introduction to Solid Waste Processing WB 3ABR56330-VII-1-P1, Introduction to Solid Waste Processing AFM 91-11, Solid Waste Management **Training Methods** Discussion (1 hr) Performance (1 hr) **Instructional Environment/Design** Classroom (1 hr) Laboratory (1 hr) Group/Lockstep **Instructional Guidance** Student will complete workbook in class. Explain responsibilities of personnel. Prepare a list of various types of solid waste so students may accomplish criterion.
2. Duties of Solid Waste Monitor	1 (1/0) Day 56	**Column 1 Reference** 2a **STS Reference** 13b(1), 13b(2), 13b(3), 13e(1), 13e(2), 13e(3), 13e(4), 13e(5), 13e(6)
a. From provided information list the duties of the solid waste monitor.	(1/0)	**Instructional Materials** SG 3ABR56330-VII-2, Duties of Solid Waste Monitor WB 3ABR56330-VII-2-P1, Duties of Solid Waste Monitor AFM 91-11, Solid Waste Management

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3	
		Training Methods Discussion (0.5 hr) Performance (0.5 hr)	
		Instructional Environment/Design Classroom (0.5 hr) Laboratory (0.5 hr) Group/Lockstep	
		Instructional Guidance This presentation is a brief overview of the duties for a solid waste processing monitor.	
3. Solid Waste Collection Planning and Procedures	6 (6/0) Days 56 and 57	**Column 1 Reference**	**STS Reference**
		3a	3c, 13e(1), 13e(2), 13e(3), 13e(4), 13e(5)
		3b	3c, 13c, 13e(6)
		3c	3c, 13b(1), 13b(2), 13b(3), 13e(2)
		3d	3c, 13e(1), 13e(3)
a. Provided information from AFM 91-11 list the factors to be considered when planning collection activities.	(1/0)	3e	13e(4)
		3f	13e(5)
b. Using AFM 91-11 and AFR 127-101, establish a set of safety precautions to be observed during collection operations of solid waste.	(1/0)	**Instructional Materials** SG 3ABR56330-VII-3, Solid Waste Collection Planning and Procedures WB 3ABR56330-VII-3-P1, Solid Waste Collection Planning and Procedures AFM 91-11, Solid Waste Management AFR 127-101, Ground Accident Prevention Handbook	
c. Using AFM 91-11 and following written instructions, determine the best locations for solid waste pickup stations, and types of storage containers.	(1/0)	Base Map **Audio Visual Aids** FLC 9-251, It Must be the Neighbors FLC 20-173, The 3rd Pollution	

PLAN OF INSTRUCTION NO 3ABR56330	DATE 6 June 1975	BLOCK NO VII	PAGE NO 50

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
d. Using AFM 91-11, list the frequency of collection of garbage, rubbish, and debris for separate collections and combined collection.	(1/0)	Training Methods Discussion (3 hrs) Performance (3 hrs)
e. Given a base map which shows solid waste pickup stations and location of the sanitary fill, lay out the most feasible route for collecting the solid waste.	(1/0)	Instructional Environment/Design Classroom (3 hrs) Laboratory (3 hrs) Group/Lockstep
f. Given AFM 91-11 and a list of various types of collecting vehicles, pickup stations, and number of pickups per day, determine the number of personnel required to perform supervisory responsibilities and driver, loader, and helper responsibilities.	(1/0)	Instructional Guidance This presentation will cover the planning for best pickup locations, routes, types of vehicles, number of personnel, and responsibilities for solid waste collection and disposal. Use of the base map will be introduced and discussed. Correlation of pertinent manuals and maps will be used to meet the objectives.
4. Solid Waste Collection and Transportation	3 (3/0) Day 57	Column 1 Reference — STS Reference 4a — 3c, 13d(1) 4b — 3c, 13d(2) 4c — 3c, 13d(3)
a. Given AFM 91-11, list the four common types of collection equipment.	(1/0)	Instructional Materials SG 3ABR56330-VII-4, Solid Waste Collection and Transportation Equipment
b. Given AFM 91-11 and various problems containing one or more of the known factors in solid waste collection and disposal procedures, select the best suited equipment to accomplish the job.	(1/0)	WB 3ABR56330-VII-4-P1, Solid Waste Collection and Transportation Equipment AFM 91-11, Solid Waste Management
c. Given AFM 91-11, list the rules for proper utilization, operation, and care of collection equipment.	(1/0)	Audio Visual Aids Training Film: MP 67-5, An Investment in Tomorrow

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS)	SUPPORT MATERIALS AND GUIDANCE
		Training Methods Discussion (1 hr) Performance (2 hrs) **Instructional Environment/Design** Classroom (1 hr) Laboratory (2 hrs) Group/Lockstep **Instructional Guidance** Emphasize the importance of proper selection and utilization of collection equipment.
5. Solid Waste Disposal Methods and Their Operation	12 (12/0) Days 58 and 59	**Column 1 Reference** — **STS Reference** 5a — 3c, 13f(1) 5b — 3c, 13f(3) 5c — 3c, 13f(2) 5d — 3c, 13f(3) 5e — 3c, 13f(3)
a. Given AFM 91-11, list the methods and operating principles of a sanitary landfill.	(1/0)	**Instructional Materials** SG 3ABR56330-VII-5, Solid Waste Disposal Methods and Their Operation WB 3ABR56330-VII-5-P1, Solid Waste Disposal Methods and Their Operation AFM 91-11, Solid Waste Management
b. Given AFM 91-11, list the items to observe to determine the correct utilization of earth moving equipment.	(2/0)	
c. Given AFM 91-11, list the standards and operating principles of incinerators.	(1/0)	**Audio Visual Aids** Slides MK 1-5, A Waste Land Saved
d. Given AFM 91-11, list the items to observe when determining the correct utilization of incinerators.	(2/0)	**Training Methods** Discussion (3 hrs) Performance (4 hrs) Field Trip (5 hrs)
e. After observing the equipment and operating procedures utilized by base sanitary landfill, name the equipment and safety precautions observed.	(6/0)	

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE	
		Instructional Environment/Design Classroom (3 hrs) Laboratory (4 hrs) Field Trip (5 hrs) Group/Lockstep **Instructional Guidance** Take students on field trip to a sanitary landfill to watch the operation at the fill and observe the equipment. Provide students with directions for accomplishing criterion objectives.	
6. Sanitation in Solid Waste Processing	1 (1/0) Day 60	**Column 1 Reference** 6a	**STS Reference** 13c, 13g
a. Provided information, list the sanitation practices to be observed by all activities related to the collection, transportation, and disposal of solid wastes.	(1/0)	**Instructional Materials** SG 3ABR56330-VII-6, Sanitation in Solid Waste Processing WB 3ABR56330-VII-6-P1, Sanitation in Solid Waste Processing AFM 91-11, Solid Waste Management **Training Methods** Discussion (0.5 hr) Performance (0.5 hr) **Instructional Environment/Design** Classroom (0.5 hr) Laboratory (0.5 hr) Group/Lockstep **Instructional Guidance** Emphasize the importance of sanitation when operating a solid waste disposal system.	
7. Public Health and Nuisance Aspects	1 (1/0) Day 60	**Column 1 Reference** 7a 7b	**STS Reference** 3c, 13c 3c, 13g
a. Using AFM 91-11, list the items that would be a health hazard or a nuisance to personnel operating a solid waste disposal system.	(0.5/0)		

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS) 2	3 SUPPORT MATERIALS AND GUIDANCE
b. Using information provided, list the disposal activities which will be coordinated with base medical services.	(0.5/0)	Instructional Materials SG 3ABR56330-VII-7, Public Health and Nuisance Aspects WB 3ABR56330-VII-7-P1, Public Health and Nuisance Aspects AFM 91-11, Solid Waste Management Training Methods Discussion (0.5 hr) Performance (0.5 hr) Instructional Environment/Design Classroom (0.5 hr) Laboratory (0.5 hr) Group/Lockstep Instructional Guidance Emphasize precautions for handling materials that would pose a health hazard to disposal personnel. Also, clarify which disposal activities must be coordinated with base medical services.
8. Forms and Reports	2 (2/0) Day 60	Column 1 Reference 8a STS Reference 3c, 13f(4), 13h
a. Given the necessary information, complete AF Form 1452 in accordance with AFM 91-11.	(2/0)	Instructional Materials SG 3ABR56330-VII-8, Forms and Reports WB 3ABR56330-VII-8-P1, Forms and Reports AFM 91-11, Solid Waste Management Training Methods Discussion (0.5 hr) Performance (1.5 hrs) Instructional Environment/Design Classroom (0.5 hr) Laboratory (1.5 hrs) Group/Lockstep

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
		Instructional Guidance Emphasize the need to maintain accurate records of all solid waste processing activities. Emphasize that the information recorded in the records is used as a basis to maintain and improve the operational procedures and safety precautions of the solid waste collection and disposal system.
9. Related Training (as shown in course chart)	10	
10. Measurement Test and Test Critique	1 (1/0) Day 60	
11. Course Critique and Graduation	1 (1/0) Day 60	

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
External Corrosion Control (Day 46)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
2 Hrs	1 Hr	3 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
40	6 June 1975	1

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VI-1 WB VI-1-P1 TF 5568 SAFB 58

CRITERION OBJECTIVES AND TEACHING STEPS

1a. Following instructions, define corrosion, list factors for corrosion to occur, list types of corrosion, and methods of prevention.

(1) Corrosion process

(2) Types of corrosion

(3) Prevention of corrosion

1b. Given samples of metals, determine kinds of corrosion on the metals and their prevention.

(1) Corrosion products

(2) Protective coating

(3) Isolation of dissimilar metals

ATC FORM AUG 72 770

BODY (110 Min)

PRESENTATION:

1a. Following written instructions, define corrosion, list factors for corrosion to occur, list types of corrosion, and methods of prevention.

(1) Corrosion process

(a) Defined as the deterioration of metal as the result of an unfavorable environment.

(b) Corrosion is caused basically by flow of electrical energy from one point to the other.

(c) All metals have electrical potential-voltage.

(d) Rate of corrosion will be in relation to position on EMF series.

1 Metal with the higher electromotive force releases ions to the metal having the lower EMF.

2 The higher electromotive force, the greater corrosion rate.

(e) Necessary elements for a corrosion cell.

1 Anode

2 Cathode

3 Electrolyte

4 Metal bond

(f) Electrical ions carry small particles of metal into the electrolyte.

1 These are dissolved and exchanged for hydrogen ions.

2 The hydrogen forms a film on the cathode.

3 This is the basic principle of galvanic corrosion.

(2) Types of corrosion

(a) Galvanic corrosion

1 Most common

2. May be used for protection of equipment.

(b) Chemical attack

1 Common in water and sewage plants due to large amounts of chemicals being handled.

2 Easily controlled

(c) All other types of corrosion are related to one or the other of these two in some manner.

(3) Prevention of corrosion

(a) Eliminate any one of the elements necessary for corrosion to occur for effective prevention.

(b) Designing against corrosion.

1 Materials that are corrosion resistant.

2 Establish conditions that make it easier to combat corrosion.

1b. Given samples of metals, determine kinds of corrosion on the metals and their prevention.

(1) Corrosion products

(2) Protective coating

(3) Isolation of dissimilar metals

APPLICATION:

Determine the corrosion process, types of corrosion, and given samples of metal, determine the types of corrosion, protection required and how to isolate the metal surface. Complete SG 3ABR56330-VI-1 and WB 3ABR56330-VI-1-P1.

EVALUATION:

Evaluate by oral or written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
Cathodic Protection (Day 46)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
2 Hrs	1 Hr	3 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
40	6 June 1975	2

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Cathodically Protected Pipeline Multimeter	None	None	SG VI-2 WB VI-2-P1 TF 6142

CRITERION OBJECTIVES AND TEACHING STEPS

2a. Identify methods of cathodic protection, list the equipment protected by cathodic methods.

(1) Cathodic protection methods

(2) Equipment protected

2b. List the installation procedures for cathodic protection, and the safety precautions to observe when working with cathodic protection systems.

(1) Installation procedures

(2) Electrical safety

ATC FORM AUG 73 770

BODY (110 Min)

PRESENTATION:

2a. Identify methods of cathodic protection, list the equipment protected by cathodic methods.

(1) Cathodic protection methods

(a) Theory of cathodic protection

1 There is a flow of electrical current between any two metals connected together in the presence of an electrolyte

2 If this current is stopped or reversed, corrosion will not occur

3 In cathodic protection, the current is retarded by passing an auxiliary current thru the electrolyte to the structure to be protected

4 Structure becomes the cathode

(b) Sacrificial anode method

1 Achieved by placing a metal object with a higher EMF in the same electrolyte with metal to be protected

2 Sacrificial anode will then flow current to metal that needs to be protected

3 This will produce a hydrogen film around metal to be protected stopping all corrosion on the metal surfaces

4 This is most economical method of protection but not always the most effective

(c) Impressed current method

1 Achieved by the addition of a direct current from an external source to increase amount of electrical current flow from anode through electrolyte.

2 More expensive but more efficient

3 Type used for protection of inside of overhead storage tanks

4 DC current is provided by tapping ac power source and using a step down transformer and a rectifier

(2) Equipment protected

(a) Overhead storage tanks

(b) Ground storage tanks

(c) Pipelines

(d) Many others as long as they are in contact with an electrolyte and connected together electrically

2b. List the installation procedures for cathodic protection, and the safety precautions to observe when working with cathodic protection systems.

(1) Installation procedures

(a) Sacrificial anode

1 Sacrificial anode must be as deep as the metal being protected

2 Pipe-to-soil potential must be lowered to at least minus 0.8 volts

3 May be necessary to wet areas to increase transfer.

(2) Electrical safety

(a) Call electrician first

(b) Turn off ac power

(c) Tape all connections

(d) Check system with voltage meter before starting work

APPLICATION: Complete WB 3ABR56330-VI-2-P1, Cathodic Protection.

EVALUATION:

Evaluate by oral or written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read SG 3ABR56330-VI-3 and answer questions in the back of the study guide.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
Drive Equipment and Accessories (Days 46 and 47)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
8 Hrs	2 Hrs	10 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
41	6 June 1975	3

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Electric Motor Gasoline Engine Drive Equipment	None	None	SG VI-3 WB VI-3-P1 WB VI-3-P2 AFM 85-13

CRITERION OBJECTIVES AND TEACHING STEPS

3a. Following written instructions, inspect, start, operate, and shut down gasoline engine-driven water pump and portable generator.

(1) Inspection and maintenance system

(2) Malfunctions that can occur

(3) Minor maintenance and servicing

(4) Safety precautions

(5) Start

(6) Operate

(7) Shut down

ATC FORM AUG 74 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

3b. Using AFM 85-13 as a guide, perform an inspection of an electric motor and correct minor discrepancies.

(1) Inspection during operation

(2) Inspections after operation

(3) Malfunctions that can occur

(4) Maintenance performed by the operator

(5) Safety precautions

3c. Following written instructions, inspect equipment having belts, chains, and variable speed drives; couplings; and shearpins. Report major maintenance to responsible organizations.

(1) Identification of drive equipment

(2) Maintenance performed by operator

(3) Maintenance performed by other organizations

(4) Safety precautions

Course No: 3ABR56330
Days: 46 and 47

Branch Approval: Bobby Littlejohn
Date: 15 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (470 Min)

PRESENTATION:

3a. Following written instructions, inspect, start, operate, and shut down gasoline engine-driven water pump and portable generator.

(1) Inspection and maintenance system

(a) A well qualified operator can tell quickly if something is wrong with his equipment

1 Sound

2 Speed

3 Temperature

(b) Daily inspections are normally made on one piece of equipment at a time

Course No: 3ABR56330
Days: 46 and 47

Branch Approval:
Date: 15 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (470 Min)

PRESENTATION:

3a. Following written instructions, inspect, start, operate, and shut down gasoline engine-driven water pump and portable generator.

(1) Inspection and maintenance system

(a) A well qualified operator can tell quickly if something is wrong with his equipment

1 Sound

2 Speed

3 Temperature

(b) Daily inspections are normally made on one piece of equipment at a time

1 Each machine has its own distinct sound

2 May be necessary to check more than one to determine where noise is coming from

(2) Malfunctions that can occur

(a) Failure to start

1 Dead battery

2 No fuel

3 Mechanical problems

(b) Overheating

1 Low water in cooling system

2 Low oil

3 Broken or loose belts

4 Leaks in cooling systems

(c) Unusual noises

1 Misaligned coupling

2 Bad clutch

(d) Internal problems

1 No oil

2 Bearings burned out

3 Burned valves

4 Cracked block

(3) Preventive maintenance

(a) Inspections

(b) Servicing

(c) Lubrication

(d) Cleaning

(e) Minor maintenance

(4) Safety precautions

(a) Install guards over drive belts

(b) Install guards over drive lines

(c) Do not fuel tanks while operating engine

(d) Provide ventilation

(e) Do not touch hot manifolds and exhaust pipes

(f) Keep hands and feet clear of all moving parts

(g) Do not wear loose clothing at any time

(5) Start

(6) Operate

(7) Shut down

APPLICATION:

Students will inspect, start, operate, and shut down gasoline engine and portable generator.

EVALUATION:

Evaluate by oral or written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (Day 46)

SUMMARY:

STUDY ASSIGNMENT:

INTRODUCTION (Day 47)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

PRESENTATION:

3b. Using AFM 85-13 as a guide, perform an inspection of an electric motor and correct minor discrepancies.

(1) Inspection during operation

    - (a) Free from dirt or moisture
    - (b) Good air circulation
    - (c) Bearing leaking oil
- (2) Inspections after operation
    - (a) Lubrication
    - (b) Cleaning
    - (c) Coupling
- (3) Malfunctions that can occur
    - (a) Unusual noises
    - (b) Sluggish operation

- (c) Vibration
- (d) Overheating

(4) Maintenance performed by operator

- (a) Lubricate as required and clean
- (b) Minor adjustments

(5) Safety precautions

- (a) Power off before maintenance
- (b) Tag power supply
- (c) Secure breaker

3c. Following written instructions, inspect equipment having belts, chains, and variable speed drives; couplings; and shearpins. Report major maintenance to responsible organizations.

(1) Identification of drive equipment

(a) Belts

1 V notch

2 Flat

3 Rubber fiber

4 Single/multiple set

(b) Chains

1 Metal links

2 Slow/medium/high speed

3 Sprockets

(c) Variable speed drives

1 Adjust speed during operation

2 Enclosed housing

(d) Couplings

1 Connect coupling to load

2 Metal

(e) Shear pins

1 Prevent damage from overloads

2 Condition of bushing

3 Replace when worn

(e) Shear pins

1 Check cause of breakage

2 Grease surface

3 Keep adequate supply of pins on hand

4 Make sure pins are right size

(3) Maintenance performed by other organizations

(a) Base CE shops

1 Metal shop

2 Electric shop

(b) Field maintenance

1 Metal shop

2 Corrosion shop

(4) Safety precautions

(a) Do not operate unsafe equipment

(b) Do not over lubricate

(c) Mark lubrication containers

(d) Be careful of loose clothing

APPLICATION:

Complete WB 3ABR56330-VI-3-P1, Drive Equipment and Accessories

Using AFM 85-13 and following instructions, the students will inspect and correct minor discrepancies on:

a. Electric motors

b. Belts

c. Chains

d. Variable speed drives

e. Couplings

f. Shear pins

EVALUATION:

Evaluate by oral, written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read SG 3ABR56330-VI-4 and answer questions in the back of the study guide.

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LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17 Jun75 W.H. Sandes	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
Pipelines, Valves, Meters, and Recorders (Day 48)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
42	6 June 1975	4

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Recorder Gate Valve Globe Valve Water Meter Pipeline Trainer	None	None	SG VI-4 WB VI-4-P1

CRITERION OBJECTIVES AND TEACHING STEPS

4a. Using the pipeline trainer and following written instructions, stop a water leak by installing a compression coupling and calculate the chemicals required, within ± 1 ounce, to sterilize the repaired extension.

(1) Method and equipment to make temporary repairs

(2) Chemicals and method of sterilizing a pipeline extension

4b. Using related information, identify procedures for locating buried pipelines, valves, and underground water leaks.

(1) List the procedures used to locate buried pipelines and valves

(2) List the methods and instruments used in locating water leaks in buried pipelines

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

4c. Using related information, identify procedures for thawing frozen pipelines.

(1) Fire

(2) Steam

(3) Direct current (arc welder)

(4) Safety precautions

4d. Following written instructions, list the methods and procedures for prevention of back siphonage.

(1) Definition of back siphonage

(2) Causes of back siphonage

(3) Danger of back siphonage

(4) Techniques and equipment used to prevent back siphonage

4e. Following written instructions, disassemble, repack, and assemble a gate valve.

(1) Types and purpose of valves

(2) Maintenance required on valves

4f. Following written instructions, inspect flowmeters, change recorder charts, and read water meters within ± 1 unit.

(1) Types of meters and dials

(2) Reading procedures

(3) Servicing recorders

(4) Inspect flowmeters

Course No: 3ABR56330
Day 48

Branch Approval:
Date: 15 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (350 Min)

PRESENTATION:

4a. Using the pipeline trainer and following written instructions, stop a water leak by installing a compression coupling and calculate the chemicals required, within ± 1 ounce, to sterilize the repaired extension.

(1) Method and equipment to make temporary repairs

(a) Plugs whittled out to fit holes

(b) Iron cement placed in and over holes

(c) Saddle clamps

(d) Compression couplings

(2) Chemicals and method of sterilizing a pipeline extension

(a) Precautions for handling chlorine solutions

(b) Repaired pipeline sections are blocked off and strong chlorine solutions injected in repaired section

(c) A chlorine residual of 50 PPM after a 24-hour contact period is required

(d) After 24 hours, the pipeline is flushed with potable water until chlorine residual is normal

4b. Using related information, identify procedures for locating buried pipelines, valves, and underground water leaks.

(1) List the procedures used to locate buried pipelines and valves

(a) Geophones (stethoscope)

(b) Probe rod

(c) Noise amplifier and ear phones

(d) Metal detectors

(2) List the methods and instruments used in locating water leaks in buried pipelines

(a) Wet areas indicate a leak below

- (b) Obtain a map of the area that shows water pipe location

- (c) Listen for hissing sound of escaping water

- (d) Check nearby manhole for clear water flow

- (e) Sound detection instruments

4c. Using related information, identify procedures for thawing frozen pipelines

- (1) Fire

- (2) Steam

- (3) Direct current (arc welder)

- (4) Safety precautions

    - (a) Use safe procedures when thawing frozen pipelines

(b) Have electrician on hand when using arc welder

4d. Following written instructions, list the methods and procedures for prevention of back siphonage

(1) Definition of back siphonage

(2) Causes of back siphonage

(a) Improper plumbing design

(b) Changes in later hook-ups

(c) Carelessness of users

(3) Dangers of back siphonage

Danger of back siphonage is dependent on the amount of pollution or type of pollution pulled into the system

(4) Techniques and equipment used to prevent back siphonage

Prevention: Back siphonage can be prevented by installing a device in the water line that will stop any backward flow. This may be a check valve or some companies build a backflow preventer. A back flow preventer senses a drop in pressure and vents the backflow to the atmosphere

4e. Following written instructions, disassemble, repack, and assemble a gate valve

(1) Types and purpose of valves

(a) Purpose: A device that stops the flow or allows an amount to flow through a system

(b) Gate valve

1 Most common

2 Fully open or closed

3 Least expensive

(c) Globe valve

1 Zero flow to wide open

2 Withstands erosion

(d) Check valve

1 No handle

2 Has flapper

3 Prevents backflow

(2) Maintenance required on valves

(a) Valves will eventually need maintenance to stay in working order

(b) The wearing parts

1 Packing

2 Stem

3 Seat

4f. Following written instructions, inspect flowmeters, change recorder charts, and read water meters within ± 1 unit.

(1) Types of meters and dials

(a) Purpose-register the amount of water that has flowed through a pipeline

(b) Types of meters

1 Positive displacement

2 Turbine or velocity

3 Compound meters

4 Venturi tube

(2) Reading procedures

(a) Some meters have a direct reading dial and are read from left to right

(b) Some are equipped with several small dials around the register. These dials register in multiples of ten

(3) Servicing recorders

(a) Water meters are fairly accurate measuring devices

(b) Common meter failures are swollen disc, scale clogged chambers, or worn measuring chamber and disc

(c) Scale and rust may be removed by a 5% solution of hydrochloric acid

(d) Organic matter may be removed by detergents or solvents

(e) Meters may be checked for accuracy by placing the meter in series with a known accurate meter or by flowing a measured volume of water through the meter

(f) Recorders are used with meters and must be maintained

1 Purpose of recorders is to provide a permanent record of flow over a period of time

2 Daily servicing of recorders

a Changing the chart

b Align chart with correct time

c Check ink supply in ink pen

3 Periodic maintenance of recorders

a Check pen travel

b Check calibration

c Clean all parts

d Lubricate all moving parts

(4) Inspect flowmeters

APPLICATION:

Using the pipeline trainer and following written instructions, stop a water leak by installing a compression coupling and calculate the chemicals required to sterilize the repaired extension.

Disassemble, repack, and assemble a gate valve.

a. Using the WB, have the students complete the section on valves

b. Caution the student not to use pliers to hold soft brass stem of the valve

Read water meters and record results

Inspect a flowmeter

EVALUATION:

Evaluate by oral or written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read SG 3ABR56330-VI-5 and answer questions at the end

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components
LESSON TITLE Chemical Feeders (Day 49)	

LESSON DURATION

CLASSROOM/LABORATORY 6 Hrs	COMPLEMENTARY 2 Hrs	TOTAL 8 Hrs

POI REFERENCE

PAGE NUMBER 44	PAGE DATE 6 June 1975	PARAGRAPH 5

STS/CTS REFERENCE

NUMBER 563X0	DATE 28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hypochlorinator, Pump and Motor Fluoridator	None	None	SG VI-5 WB VI-5-P1

CRITERION OBJECTIVES AND TEACHING STEPS

5a. Following written instructions, disassemble and reassemble a hypochlorinator.

(1) Type of chemical feeders

(2) Selection of proper tools

(3) Disassembly and assembly procedures

(4) Techniques in repairing a hypochlorinator

(5) Identify worn or damaged parts

(6) Safety precautions

ATC FORM AUG 72 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

5b. Following written instructions, disassemble and reassemble a fluoridator.

(1) Disassembly and assembly procedures

(2) Techniques in repairing a fluoridator

(3) Identify worn or damaged parts

(4) Safety precautions

Course No: 3ABR56330
Day 49

Branch Approval:
Date: 15 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (350 Min)

PRESENTATION:

5a. Following written instructions, disassemble and reassemble a hypochlorinator

- (1) Types of chemical feeders
  - (a) Solids, solutions, and gases
  - (b) Positive displacement or turbine
  - (c) Manual, semi-automatic, or fully automatic
- (2) Selection of proper tools
  - (a) No pipe wrenches
  - (b) Proper sized screw drivers
- (3) Disassembly and assembly procedures
  - (a) Disconnect power
  - (b) Disconnect all solution lines

(c) Disassembly

(d) Assembly

(4) Techniques in repairing a hypochlorinator

(a) Check proper operation

(b) Clean feeder weekly

(c) Overhaul feeder annually

(5) Identify worn or damaged parts

(a) Diaphragm, belt, worm gear, check valve

(b) Replace worn or damaged parts

(6) Safety precautions

(a) Purge feeder of all chemicals before starting any maintenance

(b) Hand tighten all plastic parts

5b. Following written instructions, disassemble and reassemble a fluoridator.

(1) Disassembly and assembly procedures

(a) Disassembly

(b) Assembly

(2) Techniques in repairing a fluoridator

(3) Identify worn or damaged parts

(4) Safety precautions

(a) Solution used in fluoridator is acid

(b) Flush completely

(c) Wipe up spillages

APPLICATION:

Complete WB 3ABR56330-VI-5-P1, Chemical Feeder Maintenance

Using equipment and tools provided and following instructions, students work in a group to disassemble and reassemble the

a. Hypochlorinator

b. Fluoridator

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read SG 3ABR56330-VI-6 and answer the questions in back of the study guide.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
Maintenance of Sewage Plant Equipment (Day 50)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
45	6 June 1975	6

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Sewage Trainer	None	None	SG VI-6 WB VI-6-P1 AFM 85-14

CRITERION OBJECTIVES AND TEACHING STEPS

6a. Using AFM 85-14 and following written instructions, list the maintenance required for grit chambers, shredders, bar screens, and sedimentation tanks.

(1) Inspection requirements

(2) Use of AFM 85-14

6b. Following written instructions, determine the items of inspection and maintenance required for a sewage lift station.

(1) Pump maintenance

(2) Alternator adjustment

ATC FORM AUG 72 770

6c. Using AFM 85-14 and following written instructions, list the maintenance required for digester, trickling filters, separators, and processing equipment.

(1) Inspection requirements

(2) Maintenance adjustments

6d. Using base sewage plant (or sewage trainer during bad weather), inspect sewage lift stations, grit chambers, shredders, bar screens, sedimentation tanks, digesters, trickling filters and processing equipment for required maintenance using class notes as a guide.

(1) Inspection of sewage lift station, grit chamber, shredder, bar screen, sedimentation tank, digester, trickling filter, and processing equipment during field trip.

(2) Deficiencies detected and required corrective maintenance actions

Course No: 3ABR56330
Day: 50

Branch Approval: Billy L Littlejohn
Date: 15 Aug 75

PART II

INTRODUCTION (10 Min)

CHECK PREVIOUS DAY'S ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (340 Min)

PRESENTATION:

6a. Using AFM 85-14 and following written instructions, list the maintenance required for grit chambers, shredders, bar screens, and sedimentation tanks.

(1) Inspection requirements

(a) Grit chambers

1 Lubricate and service reducers

2 Lubricate shaft bearing

3 Grease drive chains

4 Service chain and sprockets

5 Inspect lower bearing of grit washer

(b) Shredders and bar screens

1 Daily inspections

2 Lubrication of bearings

3 Inspection of cutting edges

  a Sand and grit will dull cutters

  b Replace with new or resharpened cutters

4 Cleaning procedures

  a Clean shredders of grit weekly

  b Clean bar screens each shift

(c) Sedimentation tanks

1 Inspection and maintenance of chains and sprockets

  a Check for wearing and cracks

  b Turn chains once to prolong life of chains

  c Sprockets have to be replaced

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2 Repair of scrapers

a Replace wooden flights

b Weld new scraper to old

3 Cleaning and lubrication

a No lubrication for equipment under water

b Chains receive grease from sewage

c Annually pump out tank for inspection

d Daily hosing prevents odors

(2) Use of AFM 85-14

(a) Reading and understanding of maintenance frequencies

(b) Guide for performing maintenance

100

6b. Following written instructions, determine the items of inspection and maintenance required for a sewage lift station.

(1) Pump maintenance

(a) Check for rags clogging pumps

(b) Adjusting packing gland

(2) Alternator adjustments

(a) Operated with 2 pumps

(b) High and Low flow

(c) Alternate pumps weekly

6c. Using AFM 85-14 and following written instructions, list the maintenance required for digester, trickling filters, separators, and processing equipment.

(1) Inspection requirements

(a) Digesters

1 Inspect digester outside walls for cracks and chalking

2 External pipes and fittings

(b) Trickling filters

1 Distribution system

a Flush arms

b Adjust guy rods

c Clean jets

2 Cleaning filter media

a Flooding

b Chlorinating

(c) Separators

1 Aerate grease

2 Industrial waste

(d) Processing equipment

1 Purpose

2 Use

(2) Maintenance adjustments

(a) Digesters

1 Check digester cover for leaks

2 Seasonal conditions

(c) Separators

1 Adjust air compressors

2 Check oil level in air compressor

3 Check and service air compressor intake filter screen as necessary

80

(d) Processing equipment

1 Check processing equipment such as drying beds, waste gas burners, and boilers

2 Flush sludge lines on sedimentation tanks

3 Drain drip trap to waste gas burners every 24 hours

4 Check and adjust pressure relief assembly

5 Maintain and adjust flame arrester and flame trap

6 Sludge withdrawal in sedimentation tank

7 Sludge withdrawal to drying beds

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6d. Using base sewage plant (or sewage trainer during bad weather), inspect sewage lift station, grit chambers, shredder, bar screens, sedimentation tanks, digesters, trickling filters, and processing equipment for required maintenance using class notes as a guide.

(1) Inspection of sewage lift station, grit chamber, shredder, bar screen, sedimentation tank, digester, trickling filter, and processing equipment during field trip.

(2) Deficiencies detected and required corrective maintenance actions.

APPLICATION:

1. List the required inspection and maintenance for the sewage lift station, grit chamber, shredder, bar screen, sedimentation tank, trickling filter, separator, and processing equipment.

2. Observe the deficiencies and determine the corrective actions on field trip to base sewage plant.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read and answer questions in study guide 3ABR56330-VI-7, and workbook 3ABR56330-7-P1, Pump Maintenance.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE
Pump Maintenance (Days 51, 52, and 53)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
16 Hrs	6 Hrs	22 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
46	6 June 1975	7

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Centrifugal Pump Turbine Pump Axial Flow Pump	None	None	SG VI-7 WB VI-7-P1 WB VI-7-P2 TVS 56-6

CRITERION OBJECTIVES AND TEACHING STEPS

7a. Given conditions of a defective centrifugal pump and a troubleshooting guide, determine and list the required maintenance for the pump.

(1) Purposes and types of pumps

(2) Operating principles of centrifugal pumps

(3) Identify major parts of a centrifugal pump

(4) Inspection and maintenance requirements

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

7b. Following written instructions, disassemble a centrifugal pump, inspect and replace defective parts, reassemble and connect pump to a drive assembly, and adjust leakage from 3 to 6 drops per minute during operational check.

(1) Selection of proper tools

(2) Pump disassembly

(3) Pump assembly

(4) Connection of pump to drive unit

(5) Operational procedures

Course No: 3ABR56330
Days: 51, 52, & 53

Branch Approval:
Date: 18 Aug 75

PART II

INTRODUCTION (10 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (940 Min)

PRESENTATION:

7a. Given conditions of a defective centrifugal pump and a troubleshooting guide, determine and list the required maintenance for the pump.

(1) Purposes and types of pumps

(a) Purposes of pumps

(b) Types of pumps

1 Centrifugal

2 Axial flow

3 Mixed flow

4 Turbine

5 Ejector well

6 Air lift

7 Reciprocating well

8 Rotary

9 Piston

(2) Operating principles of centrifugal pumps

(3) Identify major parts of centrifugal pump

(a) Pump body

(b) Pump shaft

(c) Impeller

(d) Packing gland

(e) Packing and lantern ring

(f) Suction and discharge nozzle

(4) Inspection and maintenance requirements

APPLICATION: Given conditions of a defective centrifugal pump and HO 3ABR56330-VI-7-H1, Troubleshooting Guide, have students to determine and list the required maintenance for the pump.

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Have student to complete WB 3ABR56330-VI-7-P1, Identification of Pumps and Parts.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (Day 51)

SUMMARY:

STUDY ASSIGNMENT: Answer questions in back of SG 3ABR56330-VI-7

INTRODUCTION DAY 52

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION:

7b. Following written instructions, disassemble a centrifugal pump, inspect and replace defective parts, reassemble and connect pump to a drive assembly, and adjust leakage from 3 to 6 drops per minute during operational check.

(1) Selection of proper tools

(2) Pump disassembly

(a) Bolt removal

(b) Pump separating

(c) Impeller removal

(d) Shaft removal

(e) Packing removal

(f) Bearing removal

(3) Pump assembly

(a) Install shaft and lantern ring

(b) Install impeller

(c) Install top casing

(d) Selection and cutting of packing

1 Explain selection of packing

2 Explain how to cut packing to fit shaft size

3 Install packing, replace same number of packing rings behind lantern ring as were taken out

4 Replace packing gland

(4) Connection of pump to drive unit

  (a) Alignment

  (b) Secure pump to foundation

  (c) Connect piping

(5) Operational procedures

  (a) Activate power supply

  (b) Check for vibrations

  (c) Check for overheating

  (d) Check water discharge

  (e) Adjust packing gland to allow a leak of 3 to 6 drops per minute from packing gland

APPLICATION:

Following written instructions, have students disassemble a centrifugal pump, inspect and replace defective parts, reassemble and connect pump to drive assembly and adjust leakage from 3 to 6 drops per minute during operational check. Use WB 3ABR56330-VI-7-P2.

EVALUATION:

Evaluate by oral or written questions and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION DAY 52

SUMMARY:

STUDY ASSIGNMENT: Read SG 3ABR56330-VI-8

INTRODUCTION (Day 53)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION (Continued)

Following written instructions, have students disassemble a centrifugal pump, inspect and replace defective parts. reassemble and connect pump to drive assembly, and adjust leakage from 3 to 6 drops per minute during operational check.

APPLICATION: (Continued)

Following written instructions, have students disassemble a centrifugal pump, inspect and replace defective parts, reassemble and connect pump to drive assembly and adjust leakage from 3 to 6 drops per minute during operational check. Use WB 3ABR56330-VI-7-P2.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT: NONE

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VI	BLOCK TITLE Maintenance of Water and Waste Processing System Components

LESSON TITLE

Wells and Well Maintenance (Days 53 and 54)

LESSON DURATION

CLASSROOM	LABORATORY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
47	6 Jun 75	8

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VI-8 WB VI-8-P1

CRITERION OBJECTIVES AND TEACHING STEPS

8a. Following written instructions, identify types of water wells and construction features.

(1) Water formations
(2) Types of wells
(3) Water well construction

8b. Following written instructions, list the methods and procedures for backwashing a well, cleaning well screens, and prevention of freeze up of wells.

(1) Purpose of backwashing
(2) Techniques used in backwashing
(3) Purpose of well screens
(4) Types of well screens
(5) Techniques used in cleaning well screens
(6) Methods of prevention of freeze up of wells

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

8c. Given operating data and following written instructions, calculate static level, pumping level, and drawdown, and calculate within ± 1 ounce the calcium hypochlorite needed to sterilize a well that contains 1000 gallons of water.

(1) Definition of terms
(2) Mathematical formulas relative to well production
(3) Causes of well contamination
(4) Mathematical formulas for disinfection

Course No: 3ABR56330
Days 53 and 54

Branch Approval: Billy Littlefield
Date: 20 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (350 Min)

PRESENTATION:

8a. Following written instructions, identify types of water wells and construction features.

(1) Water formations

(a) Starts from rain or snow

(b) Trapped in impervious layers

(c) Flows in aquifers of sand or gravel

(d) Top of underground water is called the water table

(2) Types of wells

(a) Bored

(b) Dug

(c) Driven

(d) Drilled

(e) Jetted

(f) Artesian

(3) Water well construction

(a) Water wells are most often drilled by contractors

(b) Water wells may vary in depth

(c) Water well casings extend from above ground level to top of the water bearing formation

(d) Casing prevents surface contamination and well from caving in

(e) The well should penetrate the full depth of the water bearing formation

(f) No standing water allowed within 50 feet of well head

APPLICATION:

Have students accomplish WB 3ABR56330-VI-8-P1, questions 1 through 14.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (Day 53)

SUMMARY:

STUDY ASSIGNMENT:

1. Review SG 3ABR56330-VI-8 and answer questions at end of chapter.
2. Read SG 3ABR56330-VI-9

INTRODUCTION (Day 54)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION:

8b. Following written instructions, list the methods and procedures for backwashing a well, cleaning well screens and prevention of freeze up of wells.

(1) Purpose of backwashing

(a) To dislodge silt

(b) Break up crusts

(c) Clean pores of formation

        - (d) Restore unrestricted flow

    - (2) Techniques used in backwashing
        - (a) Reverse flow of water
        - (b) Surge water in well
        - (c) Pressurize well (dry ice)

    - (3) Purpose of well screens
        - (a) Supports the formation
        - (b) Prevents caving in
        - (c) Permits water to flow in well

(4) Types of well screens

- (a) Reinforced wire mesh
- (b) Thinly slotted sections of pipe
- (c) Perforated pipe sections
- (d) Finely spaced wire wound on a structural skeleton

(5) Techniques used in cleaning well screens

- (a) Backwashing

(b) Surging

(c) Pressurizing

(d) Acid treating

(e) Remove from well and clean mechanically

(6) Methods of prevention of freeze up of wells

(a) Continuous pump operation lessens chance of freezing

(b) Construct a shelter over well

8c. Given operating data and following written instructions, calculate static level, pumping level, and drawdown, and calculate within ± 1 ounce the calcium hypochlorite needed to sterilize a well that contains 1000 gallons of water.

(1) Definition of terms

(a) Static level

1 Top of the water table before pumping

2 Highest level water will rise in a water well

(b) Pumping level

1 Elevation of the water level while water is being pumped

2 Level is dependent on amount being pumped and amount flowing into hole

(c) Drawdown

1 Difference between static level and pumping level

2 Rate of pumping depends on the drawdown and wells ability to recover

(d) Yield

1 Maximum yield

2 Desired yield

3 Safe yield

4 Specific capacity

(2) Mathematical formulas relative to well production

(a) Conversion of psi
(psi x 2.31 = ft)

(b) Static level = Length
of telltale - psi
before pumping x 2.31

(c) Pumping level = length
of telltale - psi
while pumping x 2.31

(d) Drawdown = psi
before pumping - psi
while pumping x 2.31
(or static level -
pumping level =
drawdown)

(3) Causes of well contamination

(a) Contamination during
drilling

(b) Surface water
contamination

(4) **Mathematical formulas for disinfection**

(a) If pipe dimension is in inches

$\frac{\pi r^2}{144}$ x length of pipe in ft x 7.48 = gals H_2O

(b) If pipe dimension is in feet

πr^2 x length of pipe in ft x 7.48 = gals H_2O

(c) lbs Cl_2 =

$$\frac{\text{gals } H_2O \times 8.34 \times \text{ppm}}{1{,}000{,}000}$$

(d) $\frac{\text{lbs } Cl_2}{\%\ \text{HTH}}$ = lbs HTH

(use decimal value for % HTH)

(e) Chlorine solution best (150 PPM)

(f) Mixed in rubber or crock containers

(g) Poured into well head

APPLICATION:

Given operating data, calculate static level, pumping level, drawdown of a well

a. Telltale measurement (see AFM 85-13, page 338)

b. Compute drawdown using problems in AFM 85-13, page 339, and page 28 in WB 3ABR56330-VI-8-P1

Calculate the amount of calcium hypochlorite required to provide the minimum strength solution to disinfect a well with 1000 gals water

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

None

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STUDY GUIDES 3ABR56330-VI-1 Thru 8

17-7

Department of Civil Engineering Training

Engineer Environmental Support Specialist

MAINTENANCE OF WATER AND WASTE PROCESSING COMPONENTS

March 1972

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

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PURPOSE OF STUDY GUIDES AND WORKBOOKS

Study Guides and Workbooks are training publications authorized by Air Training Command (ATC) for student use in ATC courses.

The STUDY GUIDE (SG) presents the information you need to complete the unit of instruction, or makes assignments for you to read in other publications which contain the required information.

The WORKBOOK (WB) contains work procedures designed to help you achieve the learning objectives of the unit of instruction. Knowledge acquired from using the student study guide will help you perform the missions or exercises, solve the problems, or answer questions presented in the workbook.

THE STUDY GUIDE AND WORKBOOK (SG/WB) contains both SG and WB material under one cover. The two training publications may be combined when the WB is not designed for you to write in, or when both SG and WB are issued for you to keep.

Training publications are designed for ATC use only. They are updated as necessary for training purposes, but are NOT to be used on the job as authoritative references in preference to Technical Orders or other official publications.

MAINTENANCE OF WATER AND WASTE PROCESSING COMPONENTS

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This publication supersedes SGs 3ABR56330-VI-1, 12 May 1971; 3ABR56330-VI-2, 1 June 1970; 3ABR56330-VI-3, 1 June 1970; 3ABR56330-VI-4, 25 February 1971; 3ABR56330-VI-5, 22 July 1970; 3ABR56330-VI-6, 26 August 1970; 3ABR56330-VI-7, 12 May 1970; 3ABR56330-VI-8, 2 April 1970; 3ABR56330-VI-9, 8 July 1970.

Department of Civil Engineering Tng
Sheppard Air Force Base, Texas

SG 3ABR56330-VI-1
6 March 1972

INTRODUCTION TO EXTERNAL CORROSION CONTROL

OBJECTIVE

The purpose of this study guide is to help you understand the processes by which metal corrodes and to help you prevent corrosion. You must be able to recognize the common types of corrosion and know the most effective methods used to prevent corrosion of plant equipment more effectively.

INTRODUCTION

Corrosion is the natural process of metals changing back to their natural state. Corrosion is essentially the same in all metals. However the rate of corrosion will vary with different types of metal, and more so in different environments. Therefore, corrosion can be defined as the deterioration of metals as a result of an unfavorable environment. This study guide will discuss the basic causes of corrosion, types of corrosion, and methods of preventing corrosion under the following main topics:

THE CORROSION PROCESS

TYPES OF CORROSION

PREVENTION OF CORROSION

This study guide will not contain all of the information you need to know about corrosion. Therefore, the research of the reference material at the end of this study guide is highly recommended.

THE CORROSION PROCESS

We already know that corrosion of metal is the deterioration as the result of an unfavorable environment. We need to know what causes some of these unfavorable environments.

For many centuries there seems to have been little curiosity regarding the causes of corrosion, although a few significant observations were made. Due to the results of these observations many extensive studies have been made in the last few years. From these studies it has been determined that the control of corrosion is a very important factor in the continuous efficient operation of water and waste systems. Corrosion attacks on utility systems can interfere seriously with the accomplishment of the base mission by causing plant shutdowns for repair and rehabilitation. It has been determined by the National Association of Corrosion Engineers that corrosion in the United States causes losses in excess of 6 billion dollars annually. The Air Force's share of this huge cost runs into several million dollars annually. This emphasizes the need for an effective control program. Such a control program cannot eliminate all corrosion, but it can reduce it by a very high precentage.

You must first understand some of the basic facts about corrosion before you can effectively control corrosion. The corrosion process is the deterioration of metal in the process of returning to its natural state. It changes into a different substance. An example is the rusting of iron. The iron actually goes through a chemical change or chemical reaction. The change from iron to iron oxide (rust) is the process of iron changing back to its natural state. If you could collect enough iron oxide it can be refined or smeltered into usable iron once more.

This deterioration of metal known as corrosion takes place in one of several different forms which will be discussed later in this lesson in more detail. The most common types or forms of corrosion that you will be dealing with in water and waste processing will be either Chemical or Electrochemical attack corrosion. These two types or forms of corrosion are caused basically by the flow of electrical energy from one point to the other.

Where does this electrical energy come from? We all have some basic knowledge of electrical energy, but in most cases not enough for a good understanding of electrical energy and corrosion currents.

All metals have electrical potential voltage. This is in the form of stored electrical energy. It might be said that this energy or potential voltage is trying to find a place to go. When two metals are joined together in the presence of an electrolyte (any liquid or moist substance that will conduct electricity) the one having the higher electrical potential gives up or releases electrical ions to the metal having the lower electrical potential.

This flow of electricity, together with the particular electrolyte involved, creates a favorable environment for the metal having the highest electrical potential to corrode. The order of electrical potential of the different common metals is given in the E.M.F. (Electromotive Force Series Chart) shown in figure 1. The speed and intensity of corrosion are determined by the amount of separation of the metals in the E.M.F. series. This can be seen by reading the voltage potential in the extreme right column of the series chart. Therefore, the greater the separation the greater the change for a corrosion cell to exist.

The E.M.F. series was developed through experiment and by measurement of the difference in electrical potential of these metals. The difference in electrical potential is caused by the atomic structure of the metal which has been developed over countless years by many scientists. In block I of this course you studied atomic structure to the extent necessary for this field of study; therefore, it will not be developed further in this course.

ELECTROMOTIVE FORCE SERIES CHART

Anodic End or Most Corrosive

METAL	ELECTRICAL POTENTIAL
MAGNESIUM	+ 2.37
ALUMINUM	+ 1.66
MANGANESE	+ 1.18
ZINC	+ 0.76
CARBON STEEL	+ 0.71
CAST IRON	+ 0.62
LEAD	+ 0.13
HYDROGEN	0.00
TIN	- 0.15
BRASS	- 0.20
COPPER	- 0.34
BRONZE	- 0.47
MERCURY	- 0.79
SILVER	- 0.80
GOLD	- 1.68

Cathodic End of Least Corrosive

Figure 1. Electromotive Force Series Chart

This table does not include all of the corrosive metals, and the metals listed will have different electrical potentials in different electrolytes.

The metal having the highest electrical potential is known as the anode or anodic area, and the metal having the lowest potential is known as the cathode or cathodic area. The anode or anodic area is the point where corrosion always occurs in metal. Small metallic particles are carried from the anode into the electrolyte and are dissolved and exchanged for hydrogen ions which flow to the cathode and tend to deposit as hydrogen film on the cathode. This is the basic principle of galvanic corrosion, which is the most common form of corrosion that will be encountered in water and waste processing equipment.

TYPES OF CORROSION

Now that you know something about the corrosion process, let's discuss types of corrosion.

Electrochemical Corrosion

This is the most common type of corrosion. It is more difficult to detect in its early stages than some other types of corrosion, and it has a much wider range of unfavorable environments to control. Electrochemical corrosion attacks any exposed metal surface.

This corrosion process is also known as galvanic corrosion. We discussed the source of electrical energy earlier in this lesson; therefore, the same basic principle that was discussed will apply to all electrochemical (galvanic) attack corrosion.

There are two rules to remember about galvanic corrosion currents. These rules will apply to all electrochemical corrosion cells.

1. Where the electrical current leaves the metal (anode) it corrodes.

2. Where the electrical current enters the metal (cathode) it is being protected.

These rules can be applied to all galvanic conditions. For a better understanding of a galvanic corrosion cell, let us use a dry cell battery as an example. The dry cell battery consists of a cathode (carbon rod), anode (zinc can), electrolyte (salmonic paste), and an electron path (the connection between the cathode and anode). This electron path is not completed until the battery is installed for operation. All dry cell batteries are constructed with these components and all galvanic corrosion cells have these same components also. See figure 2 for an example.

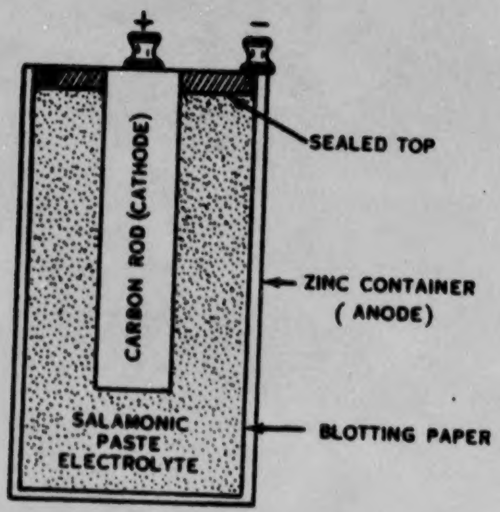

Figure 2. Dry Cell Battery

When the connection is made between the positive and negative terminals of the battery the ions start to flow creating electrical current flow. This flow will continue until the connection is broken or the anode is completely eaten up or displaced.

Electrochemical reaction means that chemical changes and an exchange of electrical energy take place at the same time. Thus, whenever corrosion occurs, there is a flow of electric current from the corroding portion of metal into the electrolyte or conductor of electricity, such as water or soil.

The electric current flowing from the metal carries particles of metal with it. The charged particles are called ions. As the metallic ions are dissolved in the electrolyte, they are exchanged for hydrogen ions, which flow to the cathode and tend to deposit a hydrogen film on the cathode. The metallic particles carried from the parent metal are usually changed to oxides as they move into the electrolyte and are deposited as corrosion products, most often near or on the anode. In the case of steel, these oxides form the familiar pattern of rust.

There are several ways in which a galvanic cell may be created. We have already discussed the dry cell battery type.

Another common type of corrosion cell is one consisting of two metals and one electrolyte as shown in figure 3.

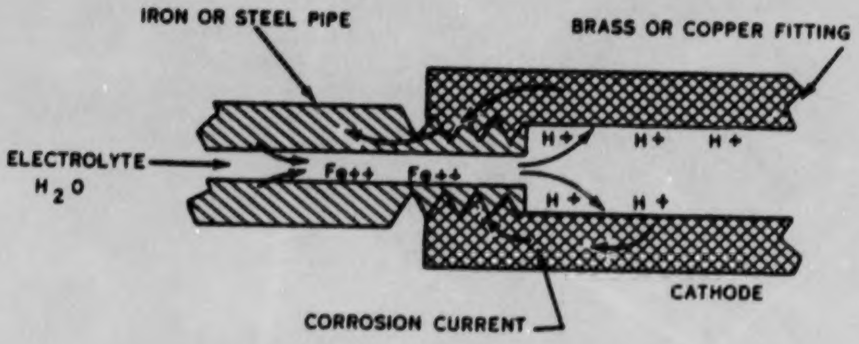
IRON OR STEEL PIPE
BRASS OR COPPER FITTING
ELECTROLYTE
H_2O
Fe^{++}
Fe^{++}
H^+
H^+
H^+
H^+
H^+
CATHODE
CORROSION CURRENT

Figure 3. Corrosion Cell

In the above example the iron or steel having the higher electrical potential gives up ions to the lower potential of the brass or copper, therefore creating a galvanic cell.

Another type of galvanic corrosion cell commonly found in water and waste systems is one on metal with a dissimilar surface on the same structure. See figure 4 for an example.

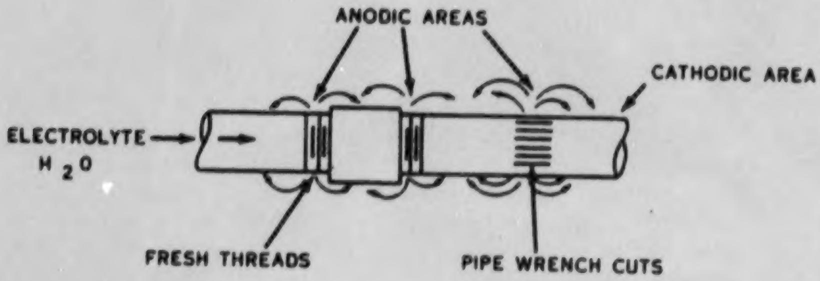
ANODIC AREAS
CATHODIC AREA
ELECTROLYTE
H_2O
FRESH THREADS
PIPE WRENCH CUTS

Figure 4. Galvanic Corrosion Cell

In figure 4 the new threads and pipewrench cuts become anodic to the remainder of the pipe due to the dissimilarity of the two surfaces regardless of it being on the same metal.

These polished or bright surfaces corrode at an accelerated rate, weakening the pipe at that point.

Chemical Attack

This is a common type of corrosion to be found in water and waste plants due to the large amounts of chemicals used in these plants.

Chemical attack of metal is easy to detect and equally easy to prevent. Most metals will react or corrode when they come into contact with acids. If you place a drop of strong acid on a piece of iron, you can see it bubbling. After a few minutes of exposure or contact with the metal, you can see the pits or holes left in the metal by the chemical attack of the acid. Some metals will resist chemical attack by acid, but will corrode readily when exposed to alkalies. Almost all metals will have some reaction with one or the other of the two.

Most chemical attack of metal occurs in industrial waste, in heavy industralized areas, or by chemical spillage. Any one of these would be considered to be an unfavorable environment and therefore, increase the amount and rate at which corrosion will progress.

Chemical attack corrosion can be prevented in most cases by preventing chemical spills, venting chemical fumes away from equipment, or by using equipment constructed of materials that will not be subject to chemical attack. Generally any measure that will eliminate the unfavorable environmental conditions will retard chemical attack corrosion.

Bacteriological Type of Corrosion

Bacterial corrosion is another type of corrosion resulting from electrolytic or galvanic cell action of biological organisms. By definition, bacterial corrosion is the deterioration of metals by corrosion processes which occur as either a direct or an indirect result of the metabolic activity of certain bacteria, particularly in water or soil environments. These biological organisms causing bacterial or biological corrosion are bacteria, slime, and fungi.

Microbiological Corrosion

Microbiological corrosion action in the soil is due to physical and chemical changes of the soil by action of these organisms. Some types of aerobic bacteria are responsible for the production of active galvanic cells. These cells are produced by the production of variations of oxygen content in the soil (differential aeration) or the reduction of the hydrogen film over the cathodic areas (depolarization).

Anaerobic bacteria are responsible for the reduction of sulfate salts into sulfide compounds. As already studied, sulfides, like hydrogen sulfide, vigorously attack most metals. Anaerobic bacteria is mostly found in highly water logged, sulfate bearing, blue clay type soils. The bacteria concentration as well as the corrosion rate varies considerably between the different seasons of the year. Cast iron and steel piping are corroded mostly by sulfide production.

PREVENTION OF CORROSION

Since we have discussed some of the causes and types of corrosion, now let's cover the most important aspects of corrosion. That is the prevention or control of corrosion.

In a given situation, corrosion may have one cause or many. Therefore, control measures must be planned to meet the specific condition.

Designing Against Corrosion

Two steps are necessary in general design: (1) To incorporate features that minimize corrosion at the outset. (2) To establish conditions that make it easier to combat corrosion showing up in subsequent operations. Proper design includes the selection of the most corrosion resistant materials for a given environment. Among light metals, aluminum, magnesium, and cadmium are relatively corrosion resistant. Corrosion resistant heavy metals include cast iron and lead. Nonferrous metals such as copper and bronze are even more corrosion resistant than the ferrous metals. In many cases nonmetallic materials may be substituted for metal.

Where possible use the same metal throughout the system to prevent galvanic action caused by dissimilar metals. When it is necessary to use dissimilar metals, use metals as close together on the electromotive series as possible. The closer two metals are on the E.M.F. series chart, the slower the rate of corrosion. See figure 1 for the E.M.F. series chart. The beginning on the chart is the least noble or more corrosive metals, progressing to the noble or least corrosive metals at the bottom of the chart.

Cathodic Protection

Another method of preventing or controlling corrosion is by cathodic protection. Cathodic protection by definition is the application of sufficient direct current to prevent currents from leaving the anodic areas of a metal structure. The entire object then becomes negative or cathodic to its surroundings. This is using the knowledge of the electromotive potential of a metal and applying enough current to make the object more noble or to have a lower electrical potential than another metal with which it is in contact with. Cathodic protection systems will be discussed fully in another lesson later in this block.

Corrosion is classified as two types: Chemical and Electrochemical. There are many different kinds of these two types of corrosion as follows:

1. Pitting - Most destructive form of corrosion, characterized by irregular surface destruction in small areas.
2. Uniform Attack - Where large areas become uniformly corroded.
3. Galvanic Corrosion - Occurs where two dissimilar metals are in contact in the presence of an electrolyte.
4. Intergranular Corrosion - Starts at the surface and penetrates the metal.
5. Exfoliation - An advanced stage of intergranular corrosion resulting in flaking or scaling off of surface.
6. Stray Current Corrosion - This occurs in areas in conjunction with industrial areas, or electric transportation systems.
7. Dezincification - This affects copper alloy tubing; the removal of zinc by corrosion leaving only the porous copper.

Since there are many different kinds of corrosion, the control or prevention of corrosion is a very complex and expensive operation. The best control or prevention is to treat corrosion in its early stages or perform preventive measures in advance to prevent the forming of corrosive cells.

PREVENTION OF CORROSION

Since you know that the necessary requirements for a corrosion cell are an anode, a cathode, an electrolyte, and an electrical path, it is apparent that to prevent corrosion from occurring, it will be necessary to remove one of the necessary requirements. Methods in which this may be accomplished are as follows:

1. Use only corrosion resistant metals.

2. Do not create galvanic cells by connecting dissimilar metals, such as iron and copper, together.

3. Use insulated couplings when such couplings must be made (to break the path of electron flow).

4. Eliminate the electrolyte.

5. Apply cathodic protection (for elimination of all anodic areas).

6. Apply protective coating over surface to prevent electrolyte from contacting surface of the metal.

Of all the above mentioned methods of preventing corrosion, the most widely used and most practical method for preventing external corrosion is painting or applying a protective coating.

There are many types of protective coatings used for this purpose. Asphalts, coal tars, plastics, mastics, greases, and concrete are a few. These coatings are considered insulating materials. They are designed to insulate or isolate the metal from the oxygen and moisture of electrolyte to prevent corrosion.

These coatings are not effective in all environments, but each one was developed to fulfill the requirements of a certain type of corrosion environment. Listed below are some of the many coatings and their uses.

Metallic coatings, such as galvanizing (zinc coating) is very effective in protecting any metallic structure or pipe against atmospheric type corrosion. This type of coating is ideal for cold water lines and metals exposed to normal atmospheric temperatures. However, at elevated temperatures, as in high temperature equipment, metals such as iron corrodes very rapidly. The reason for this is that at a critical temperature of approximately 140° F iron becomes anodic to zinc. This results in the iron becoming the sacrificial anode which corrodes readily.

Portland cement coatings have been used with success when properly applied to pipelines to be laid in highly corrosive soils such as areas containing acid mine drainage or in brackish marshes. Well mixed portland cement, generally 1 to 2, is applied to a pipeline. The thickness of the cement applied may be up to two inches thick. If the cement is properly mixed and tamped around the pipe, it may last for forty years. However, cement has the tendency to absorb moisture and crack which in many ways limits its use. In fact, where the cement cracks, electrolysis immediately starts to corrode the material. This corrosion can be reduced by painting the pipe with a bituminous primer before coating or by grounding the pipe, and by filling the cracks with asphalt or coal tar.

The portland cement coating previously discussed is applied to the outside of piping to prevent external corrosion. Portland cement coatings are now being applied to the inside of piping by a process known as the centerline process. This process involves cleaning the pipeline mechanically and coating the interior with a layer of concrete. The process can be effectively used on a pipeline having a diameter of four inches or greater.

Grease coating is another type of protective coating commonly used on piping. This grease is usually made from a petroleum base and resembles paraffin or wax. It can be applied either hot or cold; however, it must be protected by some type of wrapping in order to keep the grease from being displaced or absorbed by the backfill soil.

Asphalt and coal base coatings are by far the most common types of protective coatings used. Asphalt base coatings are produced from petroleum residue and natural resources. These coatings can take considerable abrasion or impact and temperature change without creating a corrosive condition. However, coating of this type absorbs considerable water and dissolves readily in many forms of petroleum products. Some types of asphalt coats are considerably more expensive than coal tar coatings.

Coal tar coatings are considered the most common type used on piping today. It has been proved that these coatings last longer, and they have continuity, hardness, adhesion, and resistance to corrosion. Coal tar coatings are less expensive than asphalt base coatings. This type of coating has the disadvantage of not having a very good impact resistance and a wide change of temperature often causes cracking on the surface.

Another major group is the paint and enamel protective coatings. Coal tar, asphalt, rubber, and vinyl are just a few of the paints that are mentioned in this study guide.

Coal tar paints have the outstanding characteristics of low permeability to water, resisting electrolytic reaction, and are not affected by the action of the water. These paints are recommended for piers, marine installations, flood control structures, sewage disposal plants, and industrial concrete piping.

Asphalt tar paint is especially weather resistant and durable against industrial fumes, condensation and sunlight action. Because of its resistance against water solvency, it is used on steel tanks and concrete reservoirs.

Rubber based paints such as chlorinated rubber base type are very resistant to acids, alkalies, salts, alcohols, petroleum products, and inorganic oils. Resistance to these industrial products makes this type of protective coating ideal for use on the inside of metallic and concrete storage tanks. If these structures are submerged, either in water or in the ground, a special form of this paint must be used because of condensation.

Vinyl type paints are one of the many synthetic resin base paints. This paint dries to a film that is tough, abrasion-proof and highly resistant to electrolysis. It is odorless, tasteless, nontoxic and nonflammable. This film is especially resistant to oils, fats, waxes, alcohols, petroleum solvents, formic acid, organic acids, amonium hydroxides, and phenols. Because of these characteristics it is very good for use on tanks, pipelines, well heads, off-shore drilling rigs, piping in oil industries, railroad hopper cars, dairy and brewery equipment, storage tanks containing acids and alkalies, gasoline storage tanks, and concrete exposed to corrosive environments.

Most paint, coatings or bonding material requires a primer to provide a thin layer so it will penetrate into the pores of the metal and adhere both to the metal and the paint.

Preparation of Surfaces for Protective Coating - Surface preparation before the application of a protective coating means to remove contaminants and improve adhesion of the coating. The protective coating fails in direct proportion to the lack of adhesion to the surface. Therefore, it is important that the surface is clean so that the maximum amount of adhesion is obtained.

The surface preparation methods are mentioned in three basic classes as follows: mechanical surface preparation, chemical surface preparation, and solvent cleaning and degreasing.

Mechanical Surface Preparation - Mechanical surface preparation includes hand cleaning, power tool cleaning, sand or shot blasting and flame cleaning. Hand cleaning is best adapted for spot cleaning and is not recommended for use over large areas. The operation is performed chiefly with wire brushes, abrasive cloth or paper, scrapers, knives, chisels, or chipping hammers. Hand cleaning is primarily used to remove loose scale, paint film, and caked soil.

Power cleaning is more effective and efficient over larger areas than hand cleaning. Power tools are usually pneumatic or electric driven grinders, sanders, and brushes which are able to remove corrosion products down to the bare metal. Oil and grease should be removed by a solvent before power tool cleaning in order to prevent these products from spreading over the entire surface.

Sand or shot blasting is another mechanical process used to remove mill scale, rust, rust scale, and foreign matter down to the base or white metal. The process involves abrasives shot under high pressures against the surface of the metal to be cleaned. For best results, the surface should be immediately treated with a primer coat to avoid the formation of corrosion products on the crater like surface depressions, ridges, or metal hairs produced by sand blasting.

Flame cleaning is another mechanical method of surface preparation. This method is used on structural surfaces of sufficient thickness and where warping and dehydration present a problem. Flame cleaning is used to remove unbonded mill scale and old mill scale which had not been previously painted. Flame cleaned surfaces must be painted before it is affected by condensation. This is generally done within two hours after flame cleaning while the metal is still warm.

Chemical Cleaning

The second major method of surface preparation is chemical cleaning. Chemical treatment encompasses alkali cleaning, acid pickling, steam cleaning, and phosphate surface treatment.

Alkali treatment uses a strong alkali to remove oil, grease, and soluble rust stimulators. Alkali cleaning does not remove heavy or carbonized oils or rust inhibitive oils. The surface must be neutralized with a weak acid solution so that the alkali does not attack the primers vehicle.

Acid pickling is another method of chemical treatment of metal surfaces. A weak acid such as a diluted muriatic acid is used on a degreased iron or steel surface to remove all mill scale and corrosion products. Diluted phosphoric acid or chromic acid is used right after the acid cleaning in order to protect the metal surface. When the surface is dry, a protective coating or paint is applied so as to offer a more permanent coating on the metallic surface.

Steam cleaning is another process which removes dirt, grime, grease, and loose oxidized paints, but it does not remove rust or mill scale. Detergent steam cleaning has been used with good success to remove grease from metallic surfaces. After steam cleaning, the surface is usually rinsed so that the alkali on the surface does not chemically attack the primer.

The phosphate surface treatment is a chemical process designed to treat the metallic surface with an insoluble metal phosphate which extends the life of the paint used. The metallic surface must be previously treated by some mechanical or chemical process to remove the corrosion products before the phosphate can be applied, because the metal phosphates have no effect on corrosion products. These metallic phosphates extend the life of protective paint film by improving adhesion, retarding underfilm corrosion, reducing electrochemical reaction, and reducing the decomposition of the paint vehicle. This phosphate treatment can be applied by immersion, brushing, or spraying.

Solvent Cleaning and Degreasing

The third major method of surface preparation is by solvent cleaning and degreasing. Solvent cleaning is basically used to dissolve oil and grease and does not remove rust, mill scale or corrosion products. Precautions as to the fire hazard and toxicity of solvents must be observed when this method of treatment is used.

Application of Protective Coatings

Technical Order 1-1-8 deals with application techniques, paint equipment, surface preparation, and a discussion of individual coatings. To provide optimum protection from deterioration and corrosion, the proper coating systems (combination of pretreatment, primer, and topcoat) must be selected for a specific application.

The selection of the proper coating system depends primarily on the material to be coated, the environment to which the item will be subjected, and the service life requirement of the coating. No single coating or coating system can perform adequately under all conditions to which Air Force equipment is subjected. For example, a phenolic paint conforming to Specification MIL P-12507 is good for water immersion or when subject to high humidity conditions but inadequate for exposure to an industrial atmosphere.

Many primers and topcoats can be used in various combinations; however, some primers are specifically formulated for a particular type of topcoat. The coating systems presented in Air Force Technical Order 1-1-8 adequately cover most Air Force painting and requirements.

SUMMARY

Corrosion is the deterioration of metal and can occur because of direct chemical attack or by an electrochemical reaction. Most corrosion is caused by electrochemical reaction. A corrosion cell will be created when there is an anode, cathode, electrolyte, and metal path present at the same time.

The best way to prevent or control corrosion is to eliminate any one of the necessary elements of a galvanic cell. This can be accomplished in many ways, but the most practical way is by applying a protective coating of paint or other insulating material to prevent the metal object from coming into contact with the electrolyte.

There are many different types of protective coatings, but all of these are not effective for all environments. For that reason it is necessary to have an understanding of the type of coating and the environment in which each coating would be used.

QUESTIONS

1. What is corrosion?
2. What is the most common type of corrosion?
3. Explain how painting protects metal objects from corrosion.
4. In what portion of a galvanic cell does corrosion occur?
5. What is the meaning of EMF?
6. When connecting a brass fitting to a steel pipe which is most likely to corrode first?

7. Where can cathodic protection be used?
8. What is the most important step in applying protective coatings?
9. In a galvanic cell which metal would have the highest electromotive force, the anode or the cathode?
10. What is selective attack?
11. Explain what unfavorable environment means.
12. What kind of surface preparation is steam cleaning?
13. What is the most commonly used protective coating today?
14. What factors determine the selection of the proper coating of a metal?

REFERENCES

1. AFM 85-14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems.
2. AFM 85-13, Maintenance and Operation of Water Plants and Systems.
3. TO 1-1-8, Application of Organic Coatings
4. TO 1-1-2, Corrosion Control and Treatment for Aerospace Equipment.
5. Elements of Chemistry, By Russell T. DesJordin
6. Introduction to Metallic Corrosion, By Ulick R. Evans

CATHODIC PROTECTION

OBJECTIVE

This study guide is intended to provide an understanding of cathodic protection and its application to metal structures. It will also cover some of the common tasks performed in maintaining the system.

INTRODUCTION

Cathodic protection may be used to prevent corrosion of any metal surface which is in continuous contact with an electrolyte. It may be used on buried metal surfaces such as steel pipelines and metal storage tanks. It may also be used to protect the bottom of storage tanks resting on the ground, the inside surfaces of water towers, ship hulls, and other metal structures in water. Cathodic protection will be covered under the following topics:

- THEORY OF CATHODIC PROTECTION
- METHODS OF CATHODIC PROTECTION
- EQUIPMENT PROTECTED
- MAINTENANCE OF PROTECTION SYSTEMS

THEORY OF CATHODIC PROTECTION

There is a flow of electric current between two dissimilar metals electrically connected. If the flow of this current can be stopped or reversed, theoretically the metal will not corrode. In cathodic protection, the current flow is retarded by passing an auxiliary current through the electrolyte to the metal to be protected.

METHODS OF CATHODIC PROTECTION

The flow of protective current may be motivated by sacrificial anodes (galvanic method) and by an impressed current.

To achieve cathodic protection by the galvanic method, a sacrifical anode (a metal that will corrode more readily than the one being protected) is put in the electrolyte and electrically connected to the object. Electric current will then flow from the more anodic or corroding metal through the electrolyte to the metal for which protection is desired.

The electrical connection between the two objects completes the circuit, allowing the current to return to the corroding metal. The corroding metal becomes the anode of a purposely established dissimilar metal cell, and the protected metal becomes the cathode.

Generally, the relative position of the metals in the electromotive series determines the direction of current flow. The current from the corroding sacrifical anode is strong enough to prevent all current from leaving the metal being protected. Since the cathodic protection currents flow from the electrodes they act as sacrifical anodes and disintegrate. When this happens the protected metal then becomes cathodic, or negative to its surroundings.

Metals such as magnesium and zinc which are higher in the electromotive series have been found to be very effective sacrifical anodes when coupled with iron. Iron, on the other hand, is an anode when coupled with copper. For large structures or piping systems, cathodic protection by the galvanic method is not economical and a direct current must be used.

Impressed Current System

This is the other method of cathodic protection. A direct current from an external source such as storage batteries (wet or dry), rectifiers, or generators must be used. The positive terminal of the generator or rectifier is connected by an insulated wire to the iron, carbon, or graphite electrodes buried near the structure. If it is a water tower, the electrodes will be in the water. The negative terminal is connected directly to the structure. The external power source is used to force the current through the ground (or water) to the structure and then back to the power source through the negative terminal. This current neutralizes the normal galvanic current flowing from the structure. Figure 1 illustrates this form of cathodic protection.

EQUIPMENT PROTECTED

Cathodic protection is limited in application to only certain structures, and it cannot be used to retard corrosion in general. For instance, the outside surface of a buried pipe can be protected cathodically, but not the inside of the pipe. In an elevated storage tank or ground storage tank, only the inside surface that is submerged will be protected. The outside of the tank is protected from atmospheric corrosion by painting, plating, or by applying other coatings.

Buried Pipelines

Buried pipelines are most commonly protected by using the impressed current system. It is necessary to force the current into the soil and, through it to the pipeline being protected and then return it to the source.

Contact is made with the earth by burying scrap metal such as carbon rods. See Figure 1. The current requirement provides complete protection depending on many different factors such as, pipe coating, area of exposed metal, soil resistance metal-to-soil potentials, potentials of anodic and cathodic areas, and the kind of metal in the structure. The major factor of these is the amount of metal that is exposed. For example, on a mile of bare 12-inch pipeline with about 18,000 square feet of metal surface, 100 to 150 amperes of current might be necessary for adequate protection. In a

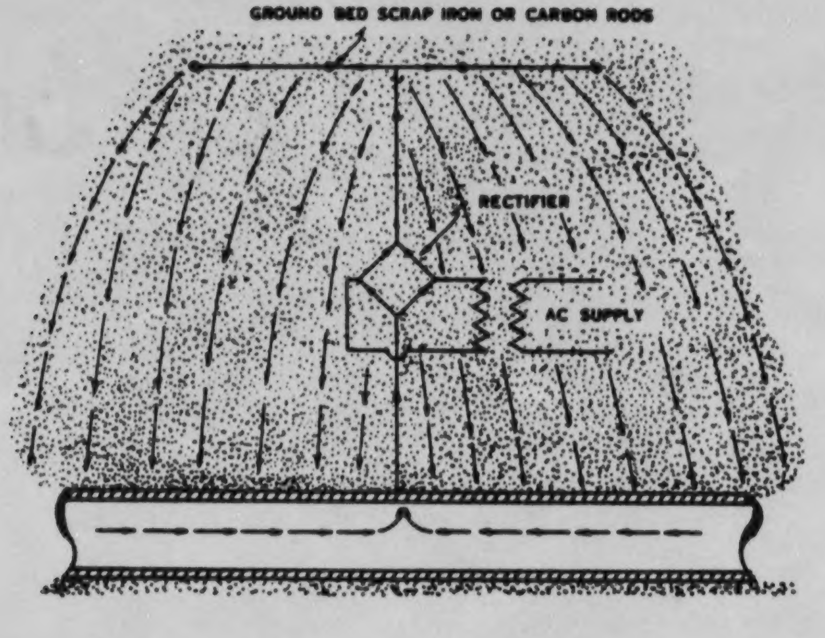

Figure 1. Cathodic Protection of Buried Pipeline Using External Power Source

mile of a well coated 12-inch line, a fraction of an ampere may be sufficient, which indicates importance of a good coating.

No general rule can be given, although for preliminary estimating purposes 0.003 amperes per square foot of bare surface is used for iron structures. When cathodic protection is installed, the external current is applied until the pipe-to-coil potential is lowered to at least minus 0.8 volts. This is measured with a multimeter and a copper-copper sulfate half cell. When the protection is maintained, corrosion will be stopped or greatly reduced.

Steel Water Storage Tanks

Cathodic protection stops corrosion by flow of direct current to the tank wall, which is the reverse of current flow that is caused by corrosion. The equipment consists of a rectifier to produce a direct current from an a.c. source, control rheostats, an ammeter, and electrodes suspended from the roof of the tank into the water. The electrodes are connected to the positive wire of a d.c. circuit. The negative wire is connected to the tank bottom, completing the circuit for current flow from the electrodes to the tank surface. Current density must be about 5.0 milliamperes per sq ft of bare metal; less if the metal is protected by paint. It is essential that the electrodes be located at different levels throughout the tank to maintain adequate protection. It may be necessary to locate the electrodes in a circle in large tanks for adequate protection. The riser (if any) will have an electrode in it to within a few feet from ground level.

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A great deal of emphasis is usually placed on the intermittently submerged surface of the tank. This and the area above the normal water line will corrode. It is for this reason that the entire interior of the tank be painted.

MAINTENANCE OF PROTECTION SYSTEMS

Impressed Current System

While equipment is in operation, note and record current flow shown by the meters. If there is no current, check the fuses, electrodes, ground wire to tank, (or pipe), and immersion of the electrodes. Check polarity and direction of current. If the connections to the rectifier are reversed, rapid damage to the tank will result.

Check the operating records and other data to be sure electrodes are normally covered with water. Maintain enough water in the tank to cover the electrodes.

Check deterioration of electrodes. The amount of corrosion will increase as the anodic area (electrodes) decrease. Replace electrodes that are badly corroded. Watch for a reduction in current flow which is a sign of a worn or failing electrode, (or sacrificial anode).

Protect the electrodes installed in elevated storage tanks from ice, which may damage them or tear them from their hangings. If ice formation is a serious problem, the only way to protect them is to remove them during cold weather. Reinstall them at the end of freezing season.

Test effectiveness of equipment by lowering the water level and removing any coating on the wall. Check this area every three months in order to insure adequate protection.

SUMMARY

Cathodic protection is a method used to prevent corrosion of both new and old structures. It is usually the only sure method of halting corrosion on underground structures. The use of impressed current reduces the rate of corrosion of metal surfaces in contact with an electrolyte. It does this by making the metal structure cathodic to its environment. The two methods by which cathodic protection may be applied are, the sacrificial anodes system and the impressed current system. The anodes must be made of a metal higher on the EMF series than that of the metal being protected.

QUESTIONS

1. What is the purpose of cathodic protection?
2. In which direction must the current flow in order to protect the metal?
3. How often is the interior of a water tank checked for cathodic protection?
4. What is the copper-copper sulfate half cell used for in cathodic protection?
5. How is the inside of the riser on an elevated storage tank protected?

REFERENCES

1. AFM 85-13, Maintenance and Operation of Water Plants and Systems
2. Corrosion Causes and Prevention by Frank N. Speller, DSC

DRIVE EQUIPMENT AND ACCESSORIES

OBJECTIVE

The purpose of this study guide is to list the common types of drive equipment and accessories found in most water and waste plants, and to acquaint you with the inspections and minor maintenance performed.

INTRODUCTION

In many cases drive equipment consists of either an electric motor or an engine. In this lesson we will discuss both units. We will also include inspection procedures and minor maintenance that you will be expected to perform.

An electric motor or engine must be connected to equipment to be of any use. How they are connected is of major importance, and we will discuss several types of connections.

There are three main topics in this lesson listed as:

* ELECTRIC MOTORS
* GASOLINE ENGINES
* DRIVE EQUIPMENT

ELECTRIC MOTORS

Electric motors supply power to many pieces of equipment in water and sewage treatment plants. The plant operator performs cleaning and minor maintenance, such as lubrication, for the equipment to function properly.

The repair is normally left to personnel assigned to the electric shop, or contract maintenance (civilian contractors). The electric shop personnel performs any major maintenance. You will be responsible for performing "before starting" inspection and services, test running the motor, and accomplishing "before stopping" inspection. If you are required to service an electric motor, it will be done in accordance with the manufacturer's specifications.

The plant operator is responsible for the minor maintenance of the electric motors as follows:

Check Motor Condition:

1. Keep motors free from dirt or moisture.

2. Keep operation space free from articles that may obstruct air circulation.

3. Check for oil leakage from bearings.

Note All Unusual Conditions

Report any of the following conditions to Civil Engineer Service Call Desk for correction by the electrical staff:

1. Unusual noises in operation.
2. Motor failing to start or come up to normal. Sluggish operation.
3. Motor or bearings feel or smell hot.
4. Continuous or excessive sparking at commutator or brushes; blackened commutator.
5. Intermittent sparking at brushes.
6. Fine dust under coupling having rubber buffers or pins.
7. Smoke, charred insulation, or solder whiskers extending from armature.
8. Excessive hum.
9. Regular clicking.
10. Rapid knocking.
11. Brush chatter.
12. Vibration.
13. Hot commutator.

Lubricate Bearings:

1. Check oil in sleeve bearings and replenish if needed.
2. Check grease in ball or roller bearings and replenish if needed.

Antifriction Bearing:

The base civil engineer may direct the plant operators to service antifriction bearings when they have the skill and tools for the required work. For procedures see AFM 85-17.

GASOLINE ENGINE

Normally gasoline or diesel engines are provided for in the case of base or commercial power failure. The repair of standby engines is the responsibility of the base ground power section. Emergency power may disturb certain processes of water and sewage treatment or cause damage to equipment. To prevent any disturance or damage, prepare a list of actions in order of their importance to be followed in case of sudden power failure; post one checklist with the piece of standby equipment and one in the plant office.

All gasoline engines must be operated continuously for at least 15 minutes each week to detect malfunctions and to keep the engine functioning properly. If an engine has not been in operation for several days, inspect before starting it. The following inspection and/or maintenance should be accomplished:

Preoperation Service

1. A visual check of fuel, oil, and water; add if necessary.

2. Check accessories and drives such as carburetor, generator, regulator, starter, belts, fan, fan shroud and water pump for loose connection or mountings.

3. Check engine for leaks (water, oil or gas) and then trace all leaks to the source, and repair or report it to proper authority.

4. Check battery and voltmeter.

5. Start the engine and let it warm up before putting it under load.

6. After the engine starts, check instruments, oil pressure, ammeter, tachometer, fuel gage, voltmeter and temperature gage.

7. After the engine is warmed to operating temperature, apply a load to engine and check controls periodically to make sure engine is operating properly. If any unusual noises occur, shut down the engine and notify the installations engineer. If engine performs well under load, check the engine periodically to assure it continues to function properly.

8. After the engine is shut down, check the water and oil level and service if necessary. Report any leaks that have developed.

9. Give engine a complete visual check.

10. Clean air cleaner and breather caps if dirty.

11. Change engine oil and filter at the elapse of specified engine running time.

12. Check fuel filters.

13. Check engine controls.

14. Check for leaks.

15. Check gear oil levels.

Additional Services

The following services should be performed weekly:

1. Check battery and voltmeter. Clean dirt from top of battery. If terminal connections or posts are corroded, clean them thoroughly and apply thin coating of CG1 grease; add water if required.

2. Check accessories and belts. Tighten or adjust loose connections, linkage, or mounting of accessories. Examine all belts for wear, cracking, correct tension and make necessary adjustment.
3. Inspect electrical wiring.
4. Check air cleaner and breather caps.
5. Check fuel filters.
6. Lubricate.

Drain oil from crankcase while engine is hot and refill with new OE 10 or OE 30, depending on conditions. For engines on standby service, any 64 hours of engine operation is considered as one week.

Malfunctions That Can Occur

1. Broken fan belt.
2. Overheating engine.
3. Cracked block.
4. Burned valve.
5. Throw rod.
6. Broken hoses.
7. Battery charge (low or dead).
8. Oil seals leaking.
9. Bad plugs (if any).
10. Inoperative electrical system.

These are just a few of the things that can go wrong with equipment if it is not properly maintained.

DRIVE EQUIPMENT

Belt Drives

Maintaining proper tension and alignment of belt drives insures long life of belts and sheaves. Incorrect alignment causes poor operation and excessive belt wear. Inadequate tension reduces the belt grip and causes high belt loads, snapping, and unusual wear.

CLEANING BELTS. Keep belts and sheaves clean and free of oil which causes belts to deteriorate. To remove oil, remove belts and wipe clean with a rag moistened in carbon tetrachloride.

REPLACING BELTS. Replace belts as soon as they become frayed, worn, or cracked. Never replace one belt on a multiple drive (2 or more). Replace the complete set with a set of matched belts. All belts in a matched set are machine-checked to insure equal size and tension.

INSTALLATION OF BELTS. Before installing belt, replace worn or damaged sheaves, then slack off on adjustments. Check multiple belts for matching size and length. Do not try to force belts into position; never use screwdriver or similar lever to get belts onto sheaves. After belts are installed, adjust tension and recheck tension after eight hours of operation.

STORING SPARE BELTS. Store spare belts in a cool dark place. Tag all belts in storage to identify them with the equipment on which they can be used.

TYPE OF BELTS. Belts are classified as to their design. The two belts most commonly used are the V-belts and flat-belts.

V-Belts. A properly adjusted V-belt has a slight bow in the slack side when running; when idle, it has an alive springiness when thumped with the hand; an improperly tightened belt feels dead when thumped. If the slack side of the drive is less than 45 degrees from the horizontal, vertical sag at the center of the span may be adjusted in accordance with the following tabulation:

Belt Tension

Span (inches)		10	20	50	100	150	200
Vertical Sag	From	0.01	0.03	0.20	0.80	1.80	3.30
(inches)	To	0.03	0.09	0.58	2.30	4.90	8.60

a. **Check Tension.** If tightening belt to proper tension does not correct slipping, check for overload, oil on belts, or other possible causes. Never use belt dressing to stop belt slippage. Rubber wearings dropping near the drive are a sign of improper tension, incorrect alignment, or damaged sheaves.

b. **Check Sheave Alignment.** Lay a long straightedge or string across outside faces of pulleys and allow for differences in dimensions from center lines of grooves to outside pulley faces of the pulleys being aligned. Be especially careful in aligning drives with more than one V-belt on a sheave, as a misalignment can cause unequal tension.

Flat Belts. Leather or rubber belts are usually used in flat-belt drives. Most flat-belt drives have either an adjustable idler pulley or a pivoted-base motor drive to maintain belt tension.

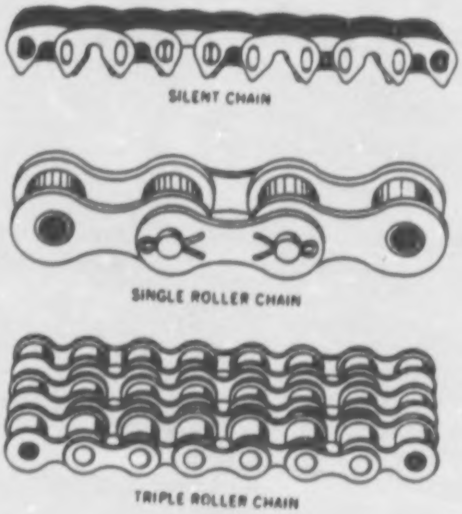
a. **Check Operation and Tension.** Check general operation conditions during regular tour of duty. Keep surroundings clean. Observe belt tension and adjust if necessary. Slapping and whipping are evidences of improper tension. If a rubber flat belt slips after tension has been properly adjusted, moisten pulley side of belt slightly with boiled linseed oil. To keep leather belts from slipping, use approved stick type belt dressing; never use rosin on leather belts.

b. **Check Alignment.** Check pulley alignment the same as for V-belts.

Chain Drives

Chain drives (figure 1) may be designed for slow, medium, or high speeds. Slow speed chain drives are serviced by removing them from their sprockets, soaked and washed in kerosene, then soaked in 30 weight oil to restore lubricating film. Remove excess lubricant by hanging chains up to drain. Do not lubricate chains that drive elevators or feeders which handle dirty or gritty material because dirt combined with lubricant forms a cutting compound which reduces chain life.

SLOW SPEED DRIVES. Because slow speed drives are not usually enclosed, adequate lubrication is difficult. Heavy oil applied to the outside of the chain seldom reaches the working parts; in addition, the oil catches dirt and grit and becomes abrasive. For lubricating and cleaning method, see paragraphs on next page.



SILENT CHAIN

SINGLE ROLLER CHAIN

TRIPLE ROLLER CHAIN

Figure 1. Types of Chain Drives

MEDIUM AND HIGH SPEED DRIVES. Medium speed drives should be continuously lubricated with a device similar to sight-feed oiler. High speed drives should be completely closed in an oil-tight case, and the oil maintained at proper level. Lubricate roller chains with 2075 or 3065.

CHECK OPERATION. Check general operation condition during regular tours of duty.

CHECK CHAIN SLACK. The correct amount of slack is essential to proper operation of chain drives. Chain drives or belts should not be tight around the sprocket; when chain is tight, working parts carry a much heavier load than necessary. Too much slack is harmful; on long centers, particularly, too much slack causes vibrations and chain whip, reducing the life of both chain and sprocket. A properly installed chain has a slight sag or looseness on the return run.

CHECK ALIGNMENT. If sprockets are not in line or if shafts are not parallel, excessive sprocket and chain wear and early chain failure results. Wear on inside of chain, sidewalls, and sides of sproket teeth are signs of misalignment. To check alignment, remove chain and place a straightedge against sides of sprocket teeth of both sprockets.

CLEANING. On enclosed types, flush chain and enclosure with kerosene. On exposed types, remove chain and soak and wash it with kerosene. If chains are too large to soak them conveniently, wash them by applying gasoline or kerosene with a brush.

CHECK LUBRICATION. Soak exposed type chains in CW IIB or in OE 30 oil to restore lubricating film. Remove excess lubricant by hanging chain to drain. Do not lubricate under water chains that operate in contact with grit. If water is clean, lubricate by applying WP or GG 1 grease with brush while chain is running. Do not lubricate chains that come in contact with dust or grit as these combine with the lubricants to form a cutting compound which shortens chain life.

CHANGE OIL. On enclosed types only, drain oil and refill case to proper level as needed or semiannually.

TROUBLESHOOTING. Some common symptoms of improper chain drive operation and their remedies are as follows:

1. **Excessive Noise.** Check alignment, proper chain slack and lubrication. Be sure all bolts are tight. If chain or sprockets are worn, reverse or renew if necessary. Frequently, additional chain life can be obtained by turning the chains over.
2. **Wear on Chain Sidewalls and Sides of Teeth.** Remove chain and correct alignment.
3. **Chain Climb Sprockets.** Check for poorly fitting sprockets and replace if necessary. Make sure tightener is installed on drive chain.
4. **Broken Pins and Rollers.** Check for chain speed which may be too high for the pitch, and poorly fitting sprockets, and replace if necessary. Breakage may also be caused by shock loads.
5. **Chain Clings to Sprockets.** Check for incorrect or worn sprockets or heavy, tacky lubricants. Replace or reverse sprockets, or change to proper lubricant.
6. **Chain Whip.** Check for centers that are too long or high pulsating loads and correct cause.
7. **Chain Gets Stiff.** Check for misalignment, improper lubrication, or excessive overloads. Make necessary adjustment and corrections.
8. **Spare Links.** Check to see if spare links are clean, oiled and ready for use.

Variable Speed Drives

A variable speed drive is used so that the operator can adjust the speed of the drive shaft to that of the rate of flow of the liquid being pumped. A variable speed is shown in figure 2.

The attention that must be given to a variable speed drive is as follows:

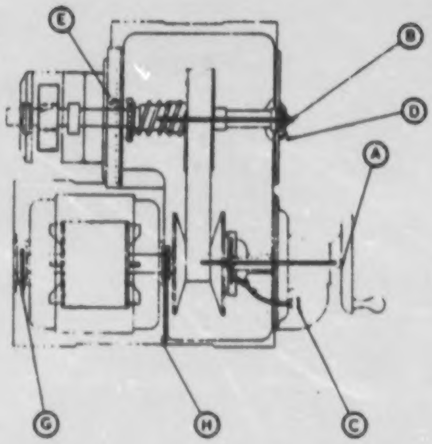


Figure 2. V-Belt Type Variable Drive

1. Check Speed-Change Mechanism. Shift drive through entire speed range to make sure shafts and and bearings are free and parts slide freely on shafts.

2. Clean Disks of Disk Drive. Remove, grease, acid, and water from disk faces and lubricate bearings. Use clear solvents that leave no residual.

3. Check V-Belt Drive.

   a. Make sure it runs level and true. If one side rides high, a disk is sticking on shaft because of insufficient lubrication or wrong lubricant. In this case, stop the drive at once, remove V-belt, and clean disk hub and shaft thoroughly with kerosene until disk moves freely. Relubricate with soft ball-bearing grease and replace V-belt in opposite direction from that in which it formerly ran.

   b. If drive is not operated for 30 days or more, shift unit to minimum speed position, placing spring on variable speed shaft at minimum tension and relieving belt of excessive pressure.

4. Lubricate Drive. Make sure to apply lubricant at all six (6) force-feed fittings (figure 2, A, B, C, D, E, G, and H), and the one cup type fitting (C); use BR grease.

   a. Once every 10 days to two weeks, use two or three strokes of grease gun through fittings A and B at ends of shifting screw and variable-speed shaft, respectively, to lubricate bearings of movable disks. Then shift drive from one extreme-speed position to the other to insure thorough distribution of lubricant over disk hub bearings.

   b. Add two or three shots of grease through fittings D and E to lubricate frame bearing on variable speed shaft.

c. Every 60 days add two or three cups full of grease to cup C. which lubricates thrust bearing on constant-speed shaft.

d. Every 60 days use two or three strokes of grease gun through fittings G and H to lubricate motor frame bearings.

CAUTION: Do not use hard grease or grease containing graphite.

5. Lubricate Gear-Type Reducer. The gear reducer is without oil when unit leaves factory. Fill the gear case with the type of oil described below until it drains out of oil plug. The reducer is provided with splash type self-lubrication, and oil supply is replenished only when it gets low. Check oil level every 60 days by removing oil hole plug. For temperatures of -10°F to 40°F. use 2075 oil. For temperatures of 40°F to 100°F, use 3080 oil. Obtain manufacturer's recommendations for lower or higher temperatures.

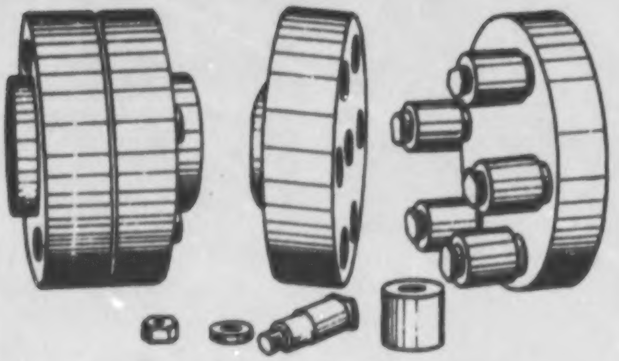
Couplings

Couplings between driving elements of a pump or any other piece of equipment must be kept in proper alignment or excessive breaking or wear may occur in the coupling, the driven machinery, or the driver. Worn or broken couplings, burned-out bearings, sprung or broken shafts and excessively worn gears are some of the damages caused by misalignment. To prevent the expense of replacing parts, check the alignment of all equipment before damage occurs.

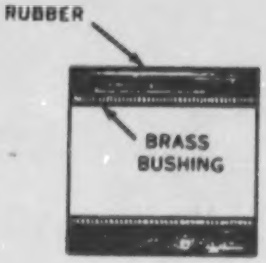
Flexible couplings (figure 3, item 1) permit easy assembly of equipment, but they must be aligned exactly as flanged couplings if maintenance and repair are to be kept to a minimum. Rubber-bushed types cannot function properly if the bolts cannot move in their bushings. Excessive bearing and motor temperatures caused by overload, noticeable vibration, or unusual noises may all be warnings of misalignment. Realign coupling, when necessary, using a straightedge and thickness gage or wedge (figure 3, item 2) to insure satisfactory operation (level to within 0.005 inch). Change oil in fast couplings (figure 3, item 3). Drain old oil and add gear oil to the proper level. If proper alignment has been secured, coupling pins can be put in place using only finger pressure. Never hammer pins into place.

Shear Pins

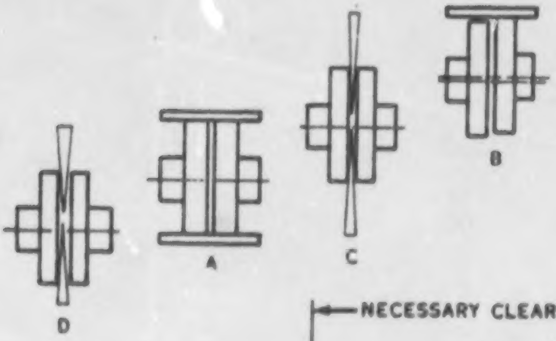
Shear pins may be found in many sewage plant units. These devices prevent damage in case of sudden overloads. To serve their purpose, these devices must be in condition to function when needed. Under unfavorable operating conditions, shearing surfaces of a shear pin device may freeze together so tightly that an overload fails to break them. Manufacturers' drawings for particular installations usually specify shear pin material and size; if not, request the information from the manufacturer, giving the model, serial number, and load conditions of unit. When necessary to determine shear pin size quickly, select by trial the lowest strength which does not break under the unit's usual loads. Never use a pin of greater strength than is required, a bolt, or a nail. If necked pins are used, be sure necked-down portion is properly positioned with respect to shearing surfaces. When a shear pin breaks, determine and remedy cause of failure before inserting a new pin and putting drive into operation.



ALLIS-CHALMERS FLEXIBLE COUPLING


RUBBER
BRASS BUSHING

CROSS SECTION OF BRASS-LINED RUBBER BUSHING



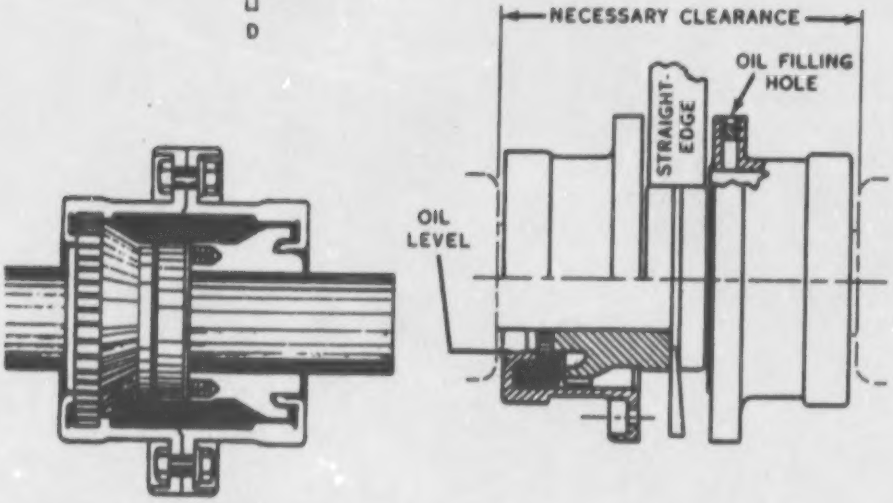

NECESSARY CLEARANCE
OIL FILLING HOLE
STRAIGHT-EDGE
OIL LEVEL

Figure 3. Couplings

To replace broken shear pin, remove broken shear pin. Lubricate the parts if necessary and operate motor for a short time with shear pin removed to smooth out any corroded or rough spots on shaft and other parts. Grease shearing pin surfaces with WB grease or OE 30.

Make sure an adequate supply of pins is on hand and that all are properly identified. Keep a record of proper pin size, necked diameter, longitudinal dimensions, and type of metal to be used.

Lubrication

Improper lubrication causes damage to wearing surfaces, increases maintenance costs, power consumption, and service outages. Lubrication instructions given in study guide include recommended lubricants and frequencies; these are intended as guides and may require modification depending on the use and type of equipment and local operating conditions.

PRECAUTIONS. Most plant equipment failures are caused by improper lubrication. The following precautions must be observed:

1. Never over lubricate. Excessive lubrication causes antifriction bearings to heat up and may damage grease seals; may also cause damage to windings in electric motors.
2. Do not lubricate completely enclosed inadequately guarded machinery while it is in operation.
3. Guard against dust, grit, and abrasives getting into containers used for storing lubricants; wipe spouts and lips clean before using containers; clean grease guns before applying grease. Use only clean grease.

GREASE FITTINGS. Lubrication can be simplified. The number of grease guns needed can be reduced, and the use of wrong lubricants can be prevented if all lubrication points requiring the same grease are fitted with the same type grease gun fitting. Each gun can then be plainly marked, according to a standard color code, for the kind of grease to be used in the gun.

IDENTIFICATION. The product symbol and identifying color should be marked on all containers, and on all grease guns and oilers used with a particular grade of lubricant. The proper markings should also be placed near oil cups and lubricating fittings to insure use of correct lubricant.

SUMMARY

By reading this study guide on the maintenance of drive equipment and accessories, you can now realize the importance of preventive maintenance. It is your job to know how and when to realign, oil, grease, clean and paint operating equipment. Also, you must know how to repair or replace parts of equipment that show signs of wear or deterioration. If a piece of equipment does break down or fails to function properly, follow the manufacturer's specifications and instructions for repairing the piece of equipment or refer to AFM 85-13 and AFM 85-14.

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Inspection of operating equipment must be conducted at certain times and during operation of the equipment to insure proper running. In this way, you can detect trouble in the equipment before it becomes serious. For example, let us take a gasoline engine driving some type of equipment. It is inspected and is found to have no oil pressure; so you shut the engine down and check it over and find it is just low on oil or maybe an oil line broke causing the loss of oil pressure. At any rate, you have saved the engine from burning up, and with a few minor repairs it is off and running again.

You also have to know what to look for when you are inspecting the equipment at treatment plants. This study guide should have given you the basic knowledge of what to look for when you are inspecting the drive equipment at treatment plants and how to take care of this equipment.

QUESTIONS

1. Name five things you may find wrong with an electric motor when you inspect it.

2. What is the minimum operating time for a gasoline engine each week?

3. What items must be checked before starting a gasoline engine?

4. What is the policy concerning multiple drive V-belts when one belt becomes frayed and worn?

5. Why are chain drives that drive equipment which handle dirty or gritty material not lubricated?

6. What are some of the things that will happen when couplings are misaligned?

7. What tolerance is allowed when aligning or realigning a coupling?

8. What is the reason for using shear pins?

9. What is used to clean belts?

10. Name two reasons why it is harmful to overlubricate equipment.

REFERENCES

1. TM 5-665, Sewerage and Sewage Treatment Facilities
2. TM 5-666, Sewage Treatment Plants and Sewer Systems at Fixed Installations
3. AFM 85-13, Maintenance and Operation of Water Plants and Systems
4. AFM 85 14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems

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MAINTENANCE OF PIPELINES, VALVES, METERS AND RECORDERS

OBJECTIVE

The purpose of this study guide is to present to you the techniques used in locating and repairing water leaks, thawing frozen pipelines, repairing valves, maintaining meters and recorders.

INTRODUCTION

A water man not only has to treat water but must also insure that it reaches the users. He is also responsible for the maintenance of the water distribution lines and controlling valves and metering devices to insure customer satisfaction and economy of operation.

The information will be presented under the following headings:

- METHODS USED IN LOCATING WATER LEAKS IN BURIED PIPELINES
- LOCATING BURIED PIPELINES AND VALVES
- TEMPORARY PIPELINE REPAIRS
- DISINFECTING PIPELINES
- METHODS USED IN THAWING FROZEN WATERLINES
- BACK SIPHONAGE
- CROSS-CONNECTIONS
- BACKFLOW
- VALVES
- PRINCIPLES OF WATER METERS
- OPERATION AND MAINTENANCE OF RECORDERS

METHODS USED IN LOCATING WATER LEAKS IN BURIED PIPELINES

The elimination of water leaks is an important part of any water works operation.

Water leaks may be caused by pipe failure due to expansion or contraction, vibration, pressure, water hammer, freezing or corrosion. They may also be caused by using defective piping, hydrants, valves and other components in the system.

Water leaks can be located by various methods: the visible flow of water from the ground; hissing noises made by escaping water; flow of clear water in manholes: metering the flow of water when increased consumption is observed: and the use of sound-detection equipment.

Most of the methods mentioned are self-explanatory with the exception of finding water leaks with sound-detection instruments.

The sound-detection instruments provide the quickest and most reliable method for detecting hidden leaks. These instruments vary from simple geophones (figure 1), which work like a doctor's stethoscope. to more sensitive electronic equipment.

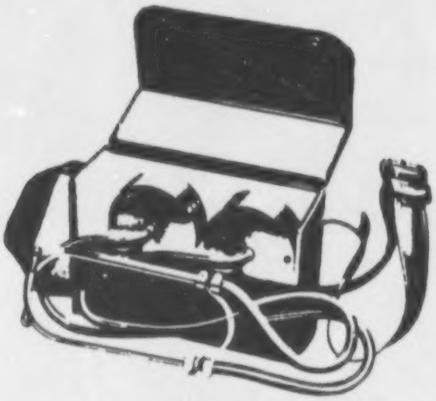

Figure 1. Geophone Leak Detecting Device

The electrically-operated water leak detector (figure 2) consists of a microphone on a probing rod, a detector box, and a set of earphones. The detectors are usually operated by dry cell batteries since they are lighter to carry than storage batteries of equal capacity.

The location of a leak may be found by pushing the probing rod in the ground until it contacts the buried pipe or valve and checking the intensity of the sound of the leak on the detector. Another way is to attach the unit to successive hydrants or valves, and compare the intensity of the sound at various points. In this way the leak may be localized to a small area where the signal is most intense.

LOCATING BURIED PIPELINES AND VALVES

The successful maintenance and operation of a water distribution system depends on accurate records of the location of all buried pipes, valves, and other components that comprise the system. A lost valve or an inaccurately located pipe may seriously delay operations during an emergency. Many valves have been improperly located on maps and records, and as a result, they have been "lost" many times. Lost valves and even pipelines have been discovered in the course of a location survey. Buried valves which have been found have sometimes been partially closed, causing inadequate water flow.

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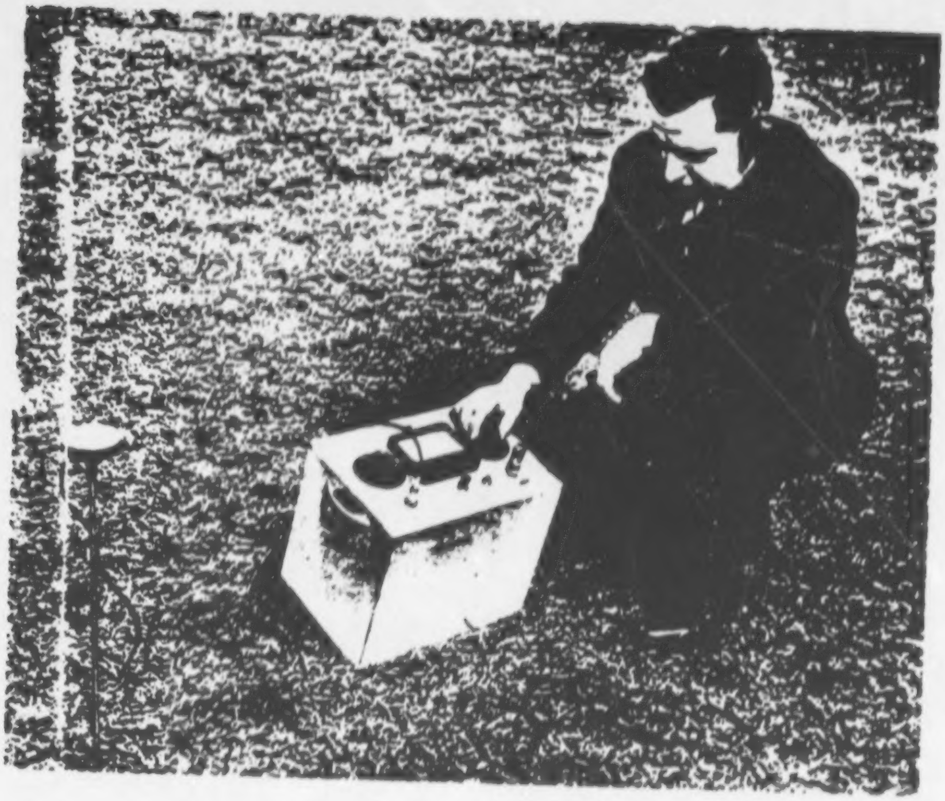


Figure 2. Microphone on Probing Rod Detects Leaks by Sound

Records and maps showing the layout of buried pipelines and valves should be evaluated periodically and revised as new equipment is added to the distribution system.

The simplest method of locating buried pipelines and valves is by probing the ground with steel rods. However, if the pipes are buried under pavement or if they are too deep to reach with steel rods, more elaborate detection devices must be used.

Electrical metal detectors may be used to locate buried pipes and valves. These instruments consist of a transmitter which sends out signals and a receiver that picks them up. The signals from the transmitter radiate through the sending aerial in all directions. When the signals or radio waves are intercepted by metal, they are distorted causing tone difference at the earphones and a deflection of the meter indicator.

Two operators are required when attempting to locate buried pipelines with electrical pipe locators. The two operators start from a fixed base line, such as a curb and advance with the instruments keeping the transmitter and receiver parallel at all times (see figure 3). If the pipes are deeply buried, the distance between the instruments should be greater than for shallowly buried pipes. The location of the pipeline will be indicated by a high reading on the meter, and an increase in tone volume (hum) in the earphone when the instruments are over the pipeline. After the pipe has been located, the instrument should be moved back and forth over the pipe until the silent zone is found. This location will be indicated by a "low-tone" or "no-tone" in the earphones and a low indicator reading. This indicates the exact center of the pipe.

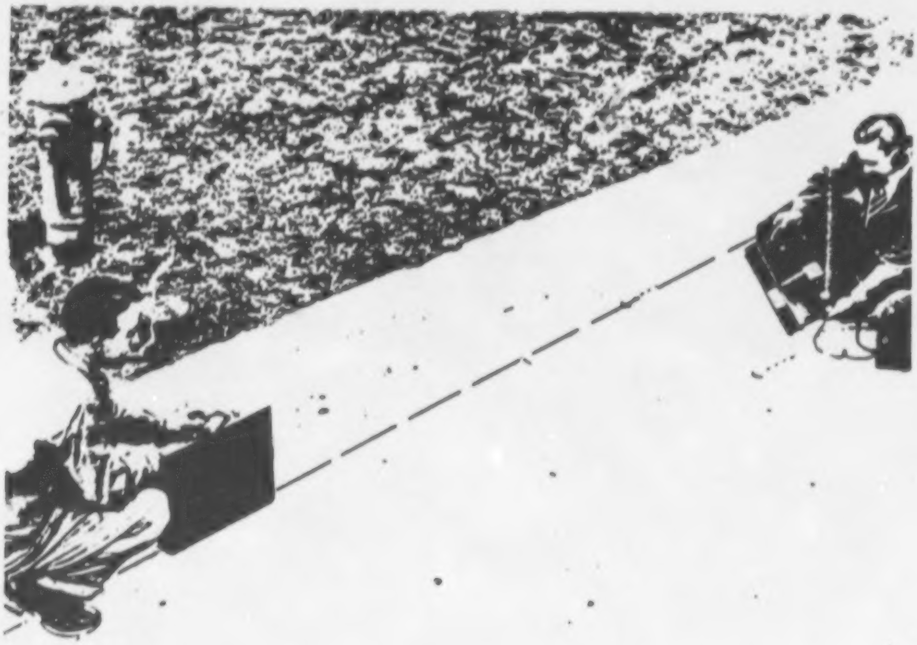


Figure 3. Locating Water Main and Determining its Depth Under Pavement

TEMPORARY PIPELINE REPAIRS

Breaks in water mains must be repaired as rapidly as possible to prevent unnecessary loss of water and to keep out-of-service periods in the affected areas to a minimum. Complete, adequate plans must be made well in advance to insure prompt repair. Telephone numbers of key personnel should be posted. Valves, keys and handtools should be available and located in specific places when not in use. Digging tools and a self-priming centrifugal portable pumps should be readily available at all times. Adequate pipe-repair materials must be kept on hand. Speed in making repairs to restore water service to the affected areas is most important.

Some of the methods used to make temporary repairs to pipes include plugging with wooden plugs, the application of iron cement, installation of saddle pipe clamps, and installation of mechanical compression couplings. The particular method used to repair a pipe depends on how badly it is damaged. For small leaks, wooden plugs may be used; but in the case of large holes, saddle clamps may be employed. The repair may require a new section of pipe. If so, the section of pipe can be connected with mechanical couplings.

DISINFECTING PIPELINES

During the construction, alteration, or repair of water pipelines, contamination of the interior surface can be expected. The dirt, rust and water collected in the pipes during transportation, storage and installation can contaminate the pipes. Therefore, to insure a safe water supply after installation and repairs, you must clean and disinfect the lines.

Flushing the lines with treated water will remove the accumulated dirt, waste water and other similar substances from the inside of the pipes; but disease germs and other harmful microorganisms must be destroyed by sterilization.

When using liquid chlorine, a gas chlorinator is used. Chlorine cylinders should not be connected directly to mains because water can enter the cylinder, cause severe corrosion, and result in hazardous leakage. Hypochlorite solution is applied by measuring pumps, by a gravity-feed mechanism, or by portable pipe disinfecting units.

Before applying the disinfectant, the section of the main to be sterilized must be thoroughly flushed with water until all dirt and mud have been removed.

The disinfectant can then be introduced from the chlorinator into an auxiliary waterline leading to one of the hydrants or taps. Air is bled from the line at the high points. The predetermined chlorine dosage is added as the main is slowly filled with water. The disinfectant is continually fed into the system until the water discharging at the other end of the section contains the desired residual chlorine. A chlorine residual of 50 p. p. m. for a 24- to 48-hour contact period is required.

After the specified contact period has been met, the unit or section is again flushed until the chlorine residual is reduced to the chlorine residual of the local supply.

METHODS USED IN THAWING FROZEN WATERLINES

In frigid or near frigid climates, cold temperatures present a major problem to water supply systems. Pipes must be insulated and heated or carried in heated conduits in areas where the ground is permanently frozen. Where seasonal freezing is the only problem, pipes must be buried below the depth to which the frost penetrates. It may also be necessary to heat stored water in cold areas. Because of a lack of proper protection against freezing, pipes may freeze in temperate as well as frigid zones. When this happens, the pipes must be thawed.

In some cases, an isolated area of pipe can be thawed out by building a fire close to the pipeline. Steam thawing is another method used. A hose connected to a boiler is inserted through a disconnected fitting and gradually advanced as the steam melts the ice.

Electrical thawing is quick and relatively inexpensive. The electrical current for the thawing operation consists of a source of current (a direct-current generator, such as a welding unit or a transformer connected to an A. C. outlet), a length of the frozen pipe, and two insulated wires connecting the current source and the pipe (figure 4). As current flows through the pipe, heat is generated and the ice within the pipe begins to

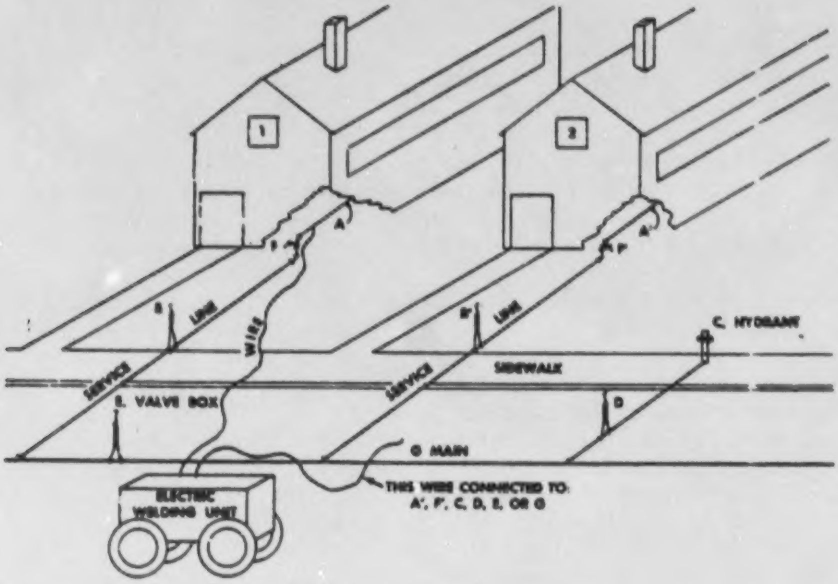


Figure 4. Connection Points for Thawing Service Lines

melt. As the water starts to flow, the remainder of the ice is progressively melted by contact with the flowing water. The wires from the current source are usually connected to nearby hydrants, valves, or exposed points at the ends of the frozen sections.

To thaw pipes with a welding generator or similar direct-current source, set the generator to the amperage required for the type of pipe to be thawed and connect the leads to the pipe. To minimize hazards, a competent electrician or lineman should set and connect the transformers, make the connections, and assist in the thawing procedures.

BACK SIPHONAGE

Public health standards require that all parts of a water supply system be free from sanitary defects and health hazards. Any physical connections between a water supply of good quality and an unsafe supply will not be permitted, nor will any connection be permitted between a potable supply and a sanitary or storm sewage system, including manholes, pumps, valve pits, or any other location that will allow unsafe or contaminated water to enter the potable supply.

CROSS-CONNECTIONS

Cross-connection is the physical connection of a safe supply and an unsafe or polluted supply. It allows liquids or chemicals of unsafe, unknown or questionable quality to flow directly into or be discharged into a potable supply.

If an installation supply is to be interconnected with an independent supply, approval of the major command and the municipality or water company concerned must be obtained.

BACKFLOW

Blackflow is the backing up of contaminated or polluted water into the potable water system.

Backflow conditions frequently occur because of improper plumbing design, subsequent changes in later hook-ups (piping), or carelessness of users.

The hazard created depends on the degree of pollution in the unsafe water, the volume of backflow that could occur, and the frequency of conditions that could cause backflow, such as negative pressure in the potable system, and improper design and installation of plumbing fixtures. Negative pressure results from line shutoffs owing to main breaks and repairs, high fire flows, especially with pumpers; inadequately sized or tuberculated pipe; pressure surges and water hammer. The following are examples of backflow conditions in different locations:

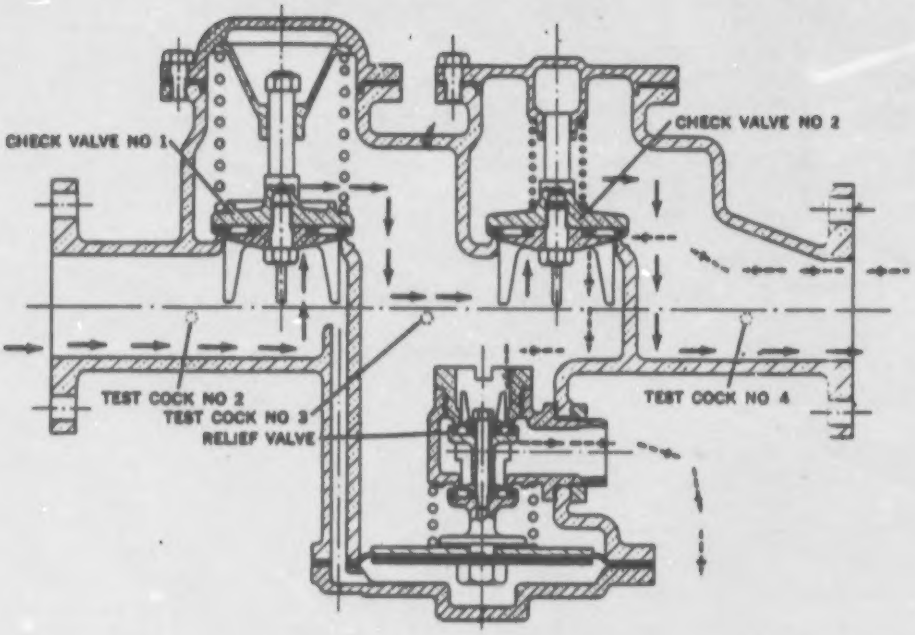
1. Water Treatment Plants. Flow between raw and treated water tanks may occur through cracked dividing walls or leaking bypass valves.
2. Valve Pits and Hydrants. Valve pits and hydrants drained to sanitary sewers are subject to flooding through sewer stoppage. Backflow can occur through leaking valve stems and through drain ports of automatic valves and hydrants.
3. Swimming Pools. Direct connections of the fresh-water inlet to the swimming pool or the recirculating piping creates possible backflow conditions.
4. Plumbing Fixtures. If pipes supplying water closet tanks, lavatories, sinks, or other similar fixtures terminate below the highest level of liquid that the fixture may hold, a danger of backflow exists. To prevent this condition, it is necessary to provide an air gap of at least 3 times the diameter of the supply pipe between the water level and the water supply.

The numerous conditions under which backflow can occur require waterworks personnel to be constantly vigilant. Periodic surveys of the system must be made by competent personnel. Occurence of nonpotable bacteriological samples from one section of a system indicates possible backflow in that area.

Backflow prevention units may be used only between two potable water systems. No connection is permitted between a potable and a nonpotable water system. This type of device affords protection against backpressure on the discharge side and negative pressure on the supply (see figure 5).

The crane backflow protection unit, shown in figure 5, is one of many units used for backflow prevention. It operates automatically by means of line pressure. The "reduced pressure" principle is applied in using air-gap break to atmosphere to create a zone within the unit where the pressure is always less than the supply pressure. Water cannot flow from this zone of low pressure into the zone of higher pressure.

A check valve (see figure 8) is another method used to control the flow of water in one direction only. Fluid flow in the proper direction keeps the valve open, and reversal of flow closes it automatically.


CHECK VALVE NO 1
CHECK VALVE NO 2
TEST COCK NO 2
TEST COCK NO 3
RELIEF VALVE
TEST COCK NO 4

TEST COCK NO 1 IS INSTALLED ON INLET GATE VALVE

Figure 5. Crane Backflow Preventer

VALVES

Valves are devices used to stop, start, or regulate flow of liquid into, through, or from piping. Essentially, a valve consists of a body containing an opening and a means of closing the opening with a disc or plug which can be tightly pressed against a seating surface or within the opening. (See figure 6.)

The most widely used types of pipeline valves are the gate, globe, and check valves.

Gate Valve

Gate valves contain a sliding disc which moves perpendicularly to the path of fluid flow and seats between and against two opposite seat faces to shut off the flow. A threaded steam and handwheel are used to lift or lower the disc, to open or close the valve.

Gate valves are used for services requiring infrequent valve operation and where the disc is kept either fully opened or fully closed. When fully opened, the seating design of the valve permits the fluid to move through the valve in a straight line with a minimum restriction of flow and a minimum loss of pressure at the valve.

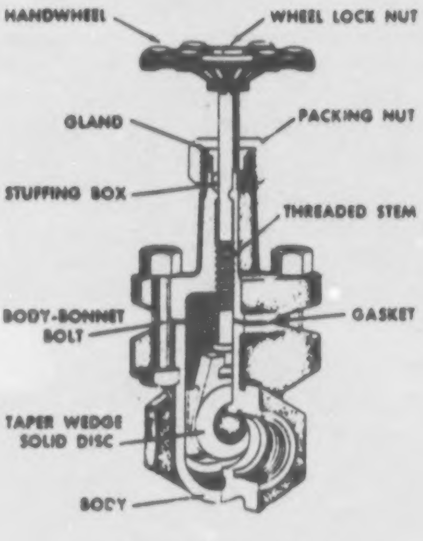

HANDWHEEL
WHEEL LOCK NUT
GLAND
PACKING NUT
STUFFING BOX
THREADED STEM
BODY-BONNET BOLT
GASKET
TAPER WEDGE SOLID DISC
BODY

Figure 6. Gate Valve

This type of valve is not suitable for a throttling operation (where the valve is kept only partly open), since the velocity of flow against the partly opened valve disc may cause vibration and damage to the disc and seating surfaces.

Most common maintenance required by gate valves is oiling, tightening, or replacing stem or stuffing-box packing.

To eliminate excessive friction between valve stem and packing, lubricate packing with a few drops of graphite-bearing oil. Use GG grease on packing which requires lubrication. Stop leakage by tightening stuffing-box nuts, forcing packing gland tightly against packing. For repacking a valve, use instructions contained in Workbook 3ABR56330-VI-4-P1.

Operate inactive gate valves to prevent sticking. Lubricate gate valves as recommended by the manufacturer. Lubricate thoroughly any gearing in large gate valves. Wash open gears with kerosene and lubricate with WB grease or 5190 oil. Clean threads on rising-stem gate valves and lubricate with WB grease.

Globe Valve

Globe valves have a horizontal interior partition which shuts off the inlet from the outlet except through a circular opening in the partition. Figure 7 shows the various components in a globe valve.

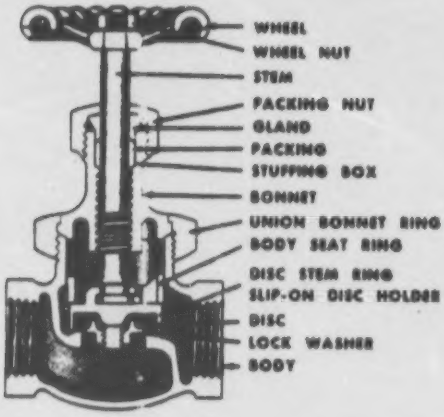


Figure 7. Globe Valve

The lower end of the valve stem contains a replaceable fiber or metallic disc, shaped and fitted to close the circular hole in the horizontal partition. The volume of flow through globe valves is roughly proportional to the number of turns of the handwheel. Surfaces of the seat and disc may be either flat or beveled, depending upon the type or disc.

Globe valves are used for services requiring frequent operation and applications where the valve is used to throttle and regulate flow. The seating design of this type of valve causes a change in direction of flow through the valve body, thereby increasing resistance to flow at the valve. The fluid flow through globe valves can be closely regulated. To insure proper operation of globe valves the following actions should be taken periodically.

Operate globe valves to prevent sticking. Check valves for leakage and adjust packing nut. When no adjustment can be made, repack valve.

To prevent serious damage, repair or replace disc and seat in globe valves when leakage occurs by following the manufacturer's specifications. Repairs on globe valves can frequently be made without removing them from the line.

Check Valves

Check valves are used when it is necessary to control the flow in one direction only. Fluid flow in the proper direction keeps the valve open and reversal of flow closes it automatically.

For installation purposes, most check valves are marked to indicate the inlet opening or direction of flow. There are two basic types of check valves: swing check valve and lift check valve (see figure 8).

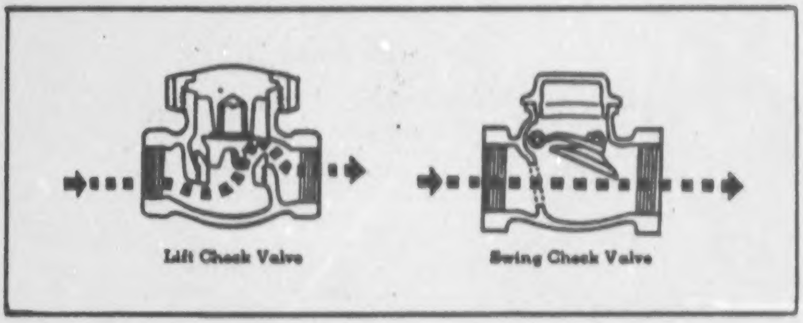


Figure 8. Check Valves

Swing check valves contain a hinged disc which seats against a machined seat in the tilted bridge wall opening of the valve body. The fluid enters below the disc. Line pressure overcomes the weight of the disc and raises it, permitting a continuous flow. If the flow is reversed or back pressure builds up, this pressure is exerted against the disc, forcing it to seat and stop the flow.

Lift check valves contain a disc which seats on a horizontal bridge wall in the valve body. The disc is raised from its seat by the pressure of the fluid flow and moves vertically to open. The disc is seated by backflow or by gravity when there is no flow.

For proper operation, check valves should be inspected periodically. Inspect disc facing; if ring is scarred, dress it with a fine file and lap with fine emery paper wrapped around a flat tool.

Check pin wear on balanced disc check valve, since disc must be accurately positioned in the seat to prevent leakage.

PRINCIPLES OF WATER METERS

Water meters and flow measuring devices measure volume and rate of flow of water. They work on three principles: volume displacement, velocity, and pressure differential.

Types of Water Meters

The main types of water meters are these: positive displacement, turbine or velocity meters, compound meters, and venturi tube meters.

POSITIVE DISPLACEMENT. The positive displacement type meters use an "oscillating piston" or a "nutating-disc" measuring device that drives a register to "count" the number of times the measuring chambers are filled and emptied. These meters should be accurate within plus or minus 2% with changing flow rates. At high flow rates, this type meter restricts the flow of water. (See figure 9.)

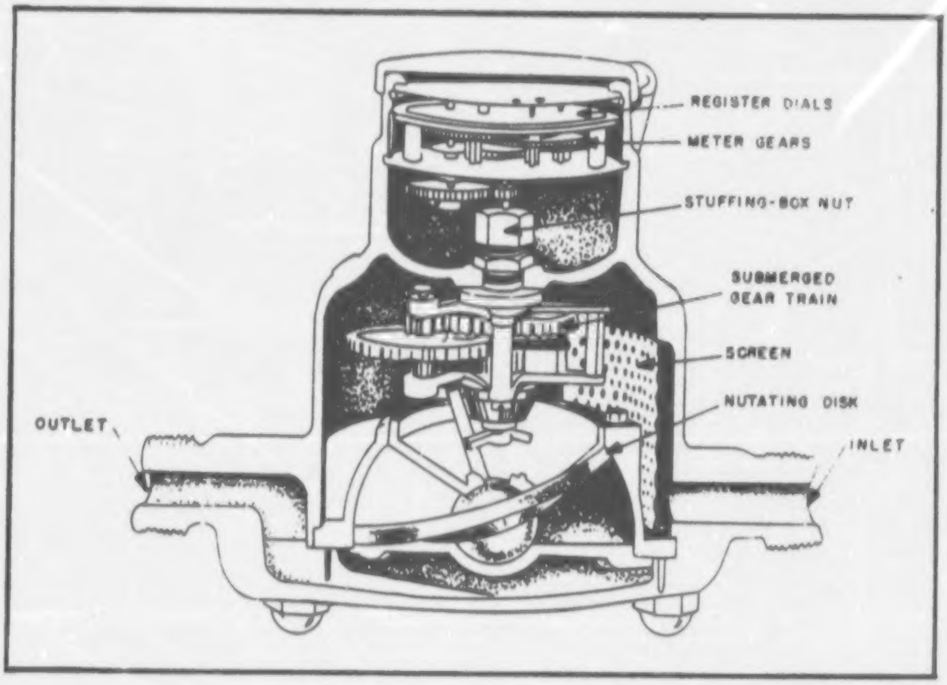


Figure 9. Nutating-Disc Water Meter

CURRENT VELOCITY METER. The current meter or turbine type meter uses a propeller device that depends on the velocity of the water to turn the recording mechanism. These meters do not restrict the flow as much at high flow rates. Their chief disadvantage is that they will not accurately measure low flow rates. (See figure 10.)

COMPOUND METER. The compound meter is a combination of a postive displacement and a velocity meter. At low flow, all the water is forced through the positive displacement meter. When the velocity increases, a valve opens and allows most of the water to pass through the velocity meter. Thus, the advantages of both meters are utilized. (See figure 11.)

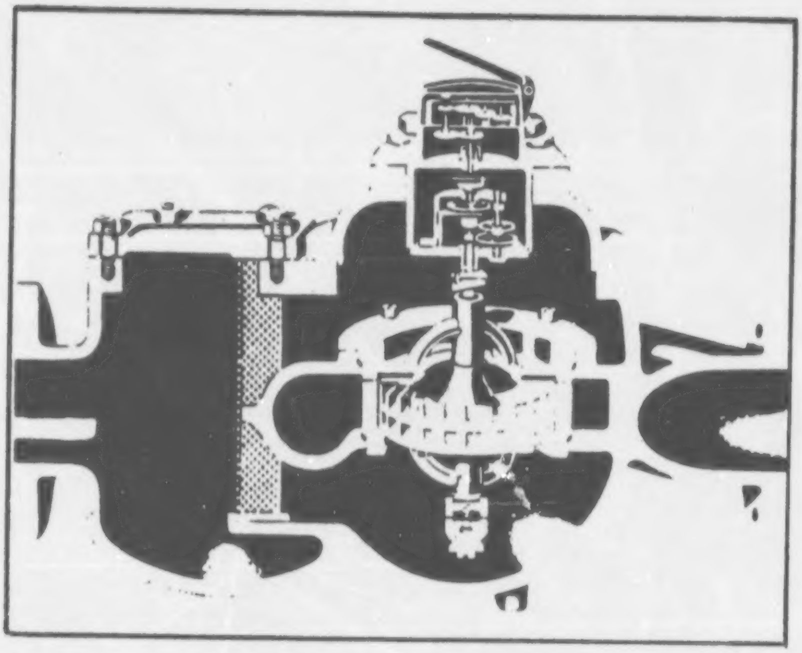


Figure 10. Current or Turbine Type Meter

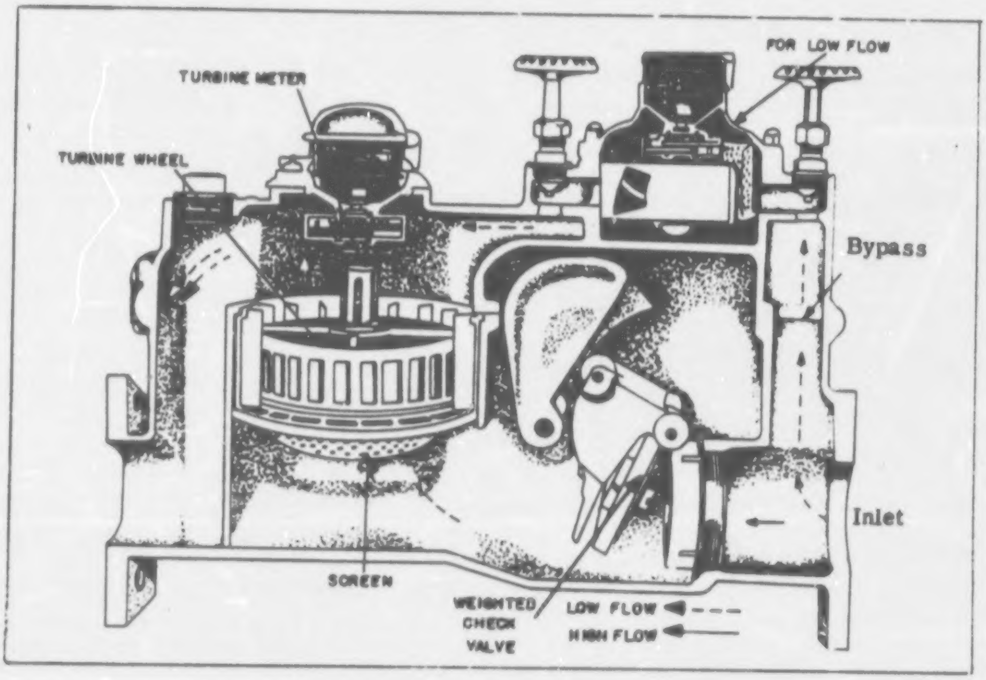

TURBINE METER
TURBINE WHEEL
FOR LOW FLOW
Bypass
Inlet
SCREEN
WEIGHTED CHECK VALVE
LOW FLOW
HIGH FLOW

Figure 11. Compound Meter

VENTURI TUBE METER. The venturi tube meter uses the principle of pressure differential to measure flow. The pressure differential through a venturi or an orifice in a pipe indicates the rate of flow. The volume of water is read from recorder charts. (Figure 12.)

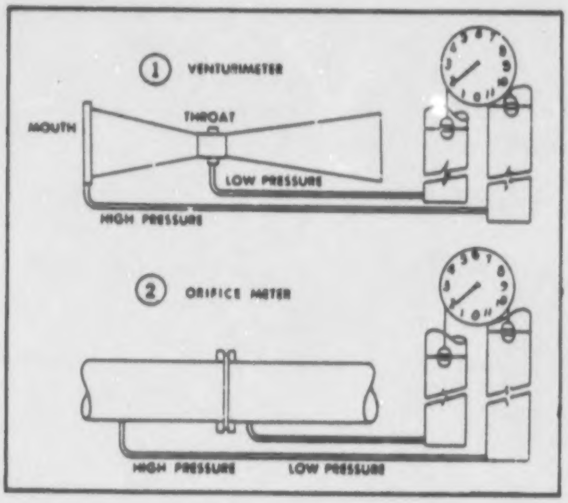


Figure 12. Venturi Meter

The venturi meter has no moving parts in the stream and it does not restrict the flow. It is not accurate at low flow rates.

Maintenance of Water Meters

Repair and maintenance of the different meters are very similar. The common failures are due to swollen discs, scale clogged chambers, or worn measuring chamber and disc. A water meter should operate for 5 to 10 years without trouble. A meter that loses its accuracy in a short time will usually be corrected by being cleaned and having the clearances rechecked. Hot water will swell the hard rubber disc and stop the meter.

Cleaning must remove rust, scale and any organic material. Scale and rust may be removed by a brief application of hydrochloric acid diluted to 5%. Organic matter can be removed with detergent solutions or solvents.

Testing Water Meters

The action of a water meter may be watched by observing the gallon indicator on the register as water is flowing through the meter. Use a flow rate of about 5 gallons per minute for a meter up to 1-1/2 inches. If no movement is noted, remove the register and watch the drive gear for movement. If the drive gear does turn, the register is faulty or the drive gears are out of mesh.

A meter may be checked for accuracy by placing it in series with a meter known to be accurate. This method is accurate enough for meters used for water treatment monitoring. For very accurate measurement, the meter should be checked by flowing a measured volume of water through the meter (see figure 13).

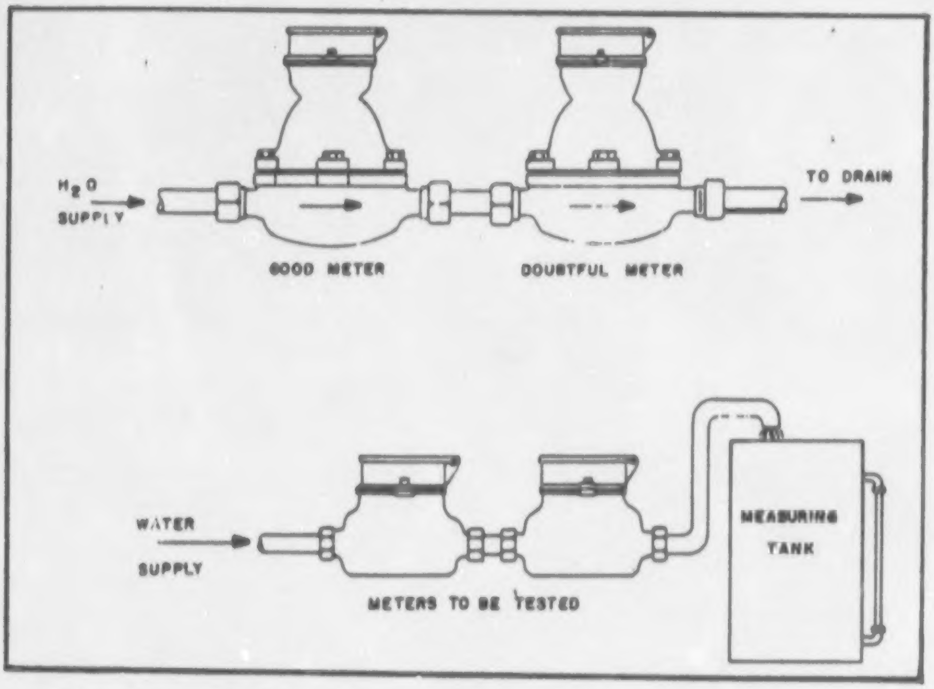


Figure 13. Testing Water Meters

All meters have a primary element and a secondary element. The primary element is in contact with and activated by the water, while the secondary element translates the action of the water flow on the primary element in terms of water quantity or rate of flow. The type of primary element determines meter type.

The secondary element of a water meter is activated by the movement or the pressure change of the primary element through either mechanical linkage or hydraulic, pneumatic, or electric impulse. They are classified below in accordance with the functions they perform:

1. Indicating devices show only the momentary rate of flow, an example is a calibrated staff gage.
2. Totalizing or integrating devices show total flow which has passed through the meter, as in a disc-type house service meter (see figure 9).
3. Recording devices show continuous rate of flow on a clock-driven chart.

OPERATION AND MAINTENANCE OF RECORDERS

Recording devices are used with various primary elements such as the venturi tube and the Parshall flume.

For example, a still well is connected with a Parshall flume, as shown in figure 14. The float in the well moves an actuating rod which changes the electric current in the transmitter. The changes in current are reflected by the movement of a pen in the recorder.

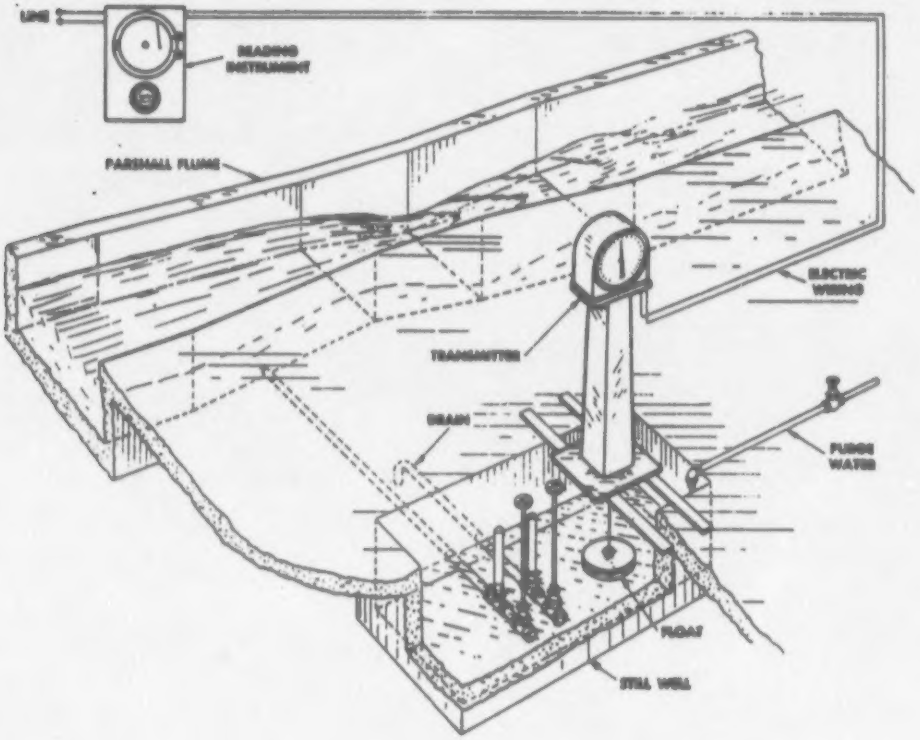

LINE
READING INSTRUMENT
PARSHALL FLUME
ELECTRIC WIRING
TRANSMITTER
DRAIN
FLUSH WATER
FLOAT
STILL WELL

Figure 14. Parshall Flume with Metering Device

The pen traces a continuous ink line on a chart which is ruled so that a direct reading can be made of the volume flow. The chart is divided into 24 divisions and makes one revolution in a day.

Daily servicing of recorders includes:

1. Changing the chart.

2. Aligning the chart with the correct time.
3. Checking the inking pen for ink supply.

You must be careful not to damage the pen when you change charts on the recorder. Lift the pen gently when removing a chart. If you start a new chart at 8 o'clock in the morning, be sure that the chart is turned so that the 8 o'clock line will be directly under the pen. Be careful not to drop the pen when replacing it on the chart. When you add ink to the pen, be careful to put in only the amount required. Too much ink in the pen will flood it and ruin the chart.

Be sure that the chart is marked with the starting date, time, and the finish date and time. If the chart has a spring drive, wind the spring; but do not wind it so tightly that the mechanism will be damaged.

Periodic maintenance of recorders is accomplished according to manufacturer's specification. Maintenance includes checking pen travel, checking calibration, cleaning all parts and lubricating all moving parts.

SUMMARY

Locating water leaks quickly, to insure proper operation and service, is very important. There are various methods used to locate leaks ranging from listening for hissing sounds to the use of sound detection instruments. All leaks should be repaired as soon as possible, and the water systems placed back into service.

In order to operate and maintain a distribution system, accurate and up-to-date records of all buried pipes, valves, and other components should be kept readily available.

Some of the methods used to repair leaks in water pipes include plugging with wooden plugs, the application of iron cement, use of mechanical compression couplings and installation of saddle pipe clamps. The particular method used depends on how badly the pipe is damaged. The pipes have to be disinfected after repairs are made.

In cold climates, frozen water lines become a problem. Pipes can be thawed by building a fire close to the pipe, steam thawing, or electrical thawing.

Back siphonage can become a health hazard. Where the possibility of back siphonage could exist backflow preventers must be installed.

Leaky or inoperative valves are another problem common to the distribution system. Valves should always be kept in good operation for proper control of water flow. The most widely used types of valves are the gate, globe, and check valves.

Water may be measured in terms of rate of flow or total volume. Units and equivalents usually used are: cubic feet per second (c.f.s) is used to measure rate of stream flow; gallons per minute (g.p.m.) expresses pump output; million gallons per day (m.g.d.) expresses daily flow or rate of flow; and thousands of gallons per day is also used in preparing reports.

Due to close tolerances used in the manufacture of water meters sticking or binding may develop from accumulations of scale and sand or use of hot water. When trouble develops, the meter should be cleaned and checked for accuracy. A check with another dependable water meter is accurate enough for normal water treatment control purposes.

Recorders are sensitive instruments. They should be handled carefully to prevent damage. Daily servicing of recorders includes changing the chart, aligning the chart for the correct time, and checking the ink supply. The charts are kept as a daily record of total plant flow.

QUESTIONS

1. Name six causes of water leaks.
2. Name five methods used in locating water leaks.
3. What is required for the successful maintenance and operation of a water distribution system?
4. What is the simplest method used for locating buried pipelines and valves?
5. What items of equipment are kept readily available for emergency pipeline repair?
6. Name four methods used for temporary pipeline repair.
7. What is the required chlorine residual content and contact time for disinfecting pipelines?
8. Name three methods used for thawing frozen pipelines.
9. What is a cross-connection?
10. What three conditions can cause backflow.
11. Name two methods used to prevent backflow?
12. Why can't a gate valve be used for throttling service?
13. What are the two basic types of check valves?
14. What type of meter uses a nutating disc?
15. How are scale and rust removed from water meters?

REFERENCES

1. AFM 85-13, Maintenance and Operation of Water Plants and Systems.
2. AFM 85-14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems.

CHEMICAL FEEDERS

OBJECTIVE

The objectives of this study guide are to increase your knowledge of the different types of chemical feeders and to help prepare you to operate and maintain this equipment.

INTRODUCTION

Water treatment usually includes the feeding of chemicals at a controlled rate which is in proportion to the volume of water being treated. Various types of chemical feeders are available; the three main types being gas feeders, solution feeders, and dry chemical feeders (these terms indicate the state or condition of the chemical when it is added to the water).

The information in this study guide will be presented under the following main headings:

- GAS FEEDERS
- SOLUTION FEEDERS
- DRY CHEMICAL FEEDERS

You are encouraged to read the more extensive coverage of this information which is contained in the material referenced at the end of this study guide.

GAS FEEDERS

Gas Chlorinators

The chemical gas feeder which you are most likely to operate for the Air Force is a gas chlorinator. With respect to the method by which the discharge rate is controlled, there are three types of gas chlorinators: (1) manually controlled type, where the equipment must be started and stopped manually, and the rate-of-feed is manually adjusted to the rate of water flow; (2) semiautomatic type, where the equipment starts and stops automatically, but must be manually adjusted to the rate of water flow; (3) fully automatic type. Note, in all three types, the amount of chemical dosage is set by manual adjustment.

Gas chlorinators may also be classified as being either direct feed or solution feed.

DIRECT FEED CHLORINATORS. This type feeds the chlorine gas directly into the water being treated. Direct feed chlorinators may be called "pressure gas chlorinators" or "direct diffusers" and are used chiefly as emergency equipment on small installations where it is not possible to obtain a water supply suitable for operating a solution feeder. They cannot be used where the pressure of the water is more than 20 p.s.i. Due to the chlorine being under pressure as a gas at all times, they are highly susceptible to leaks. Should a chlorine gas leak occur, there will be extensive corrosion on adjacent equipment and structures.

SOLUTION FEED CHLORINATORS. There are two general types of solution feed chlorinators: (1) the "bubbling" or "pulsating" reduced pressure type, (2) the "vacuum" type. Since all solution feed chlorinators keep the chlorine gas under a partial vacuum, they cause fewer chlorine leaks than the pressure gas chlorinators. Note, vacuum type solution feed chlorinators have largely replaced the pulsating type solution feed chlorinators.

The solution feed chlorinators are also classified by the type of diaphragm used in controlling the chlorine feed. One type uses a water diaphragm, while the other type uses a mechanical diaphragm. The water diaphragm is always a vacuum type, so it has the advantage of being friction free and having a puncture-proof diaphragm.

PREVENTIVE MAINTENANCE. In order for gas chlorinators to operate satisfactorily for lengthy periods, it will be necessary for the operator to perform the following preventive maintenance inspections. The following inspection intervals are based on the recommendations of experienced engineers and operators, the equipment guides of manufacturers, and standard text books.

a. Each DAY the equipment is operated:

(1) Inspect for leaks. Examine chlorinator and all piping for chlorine or water leaks. All chlorine leaks are serious because they increase rapidly in size and cause extensive corrosion and damage. Red discoloration means scale. To locate chlorine leaks, hold the mouth of an unstoppered ammonia-water bottle near all joints, valves, and along piping; any white fumes from the bottle are ammonium chloride and indicate a chlorine gas leak. Keep ammonia-water bottle tightly stoppered when not in use to prevent loss of strength.

(2) Operate Chlorine Valves. Open and close all chlorine valves to prevent threads on the valve stems from becoming set in one position. Do not use force in closing a valve. Check stuffing boxes. Repair or replace faulty valves at once.

(3) Check Gas System. Check that all piping and parts carrying chlorine gas are operating properly. See that metering devices, pressure reducing and shut-off valves function properly. Disassemble and clean where necessary, determining the cause of the fault. At first sign of weakening, replace any faulty parts.

(4) Check Vacuum Relief. Make sure the entire assembly operates properly and that the relief hose is not plugged. Insects, such as mud daubers, may plug such lines by building nests in them.

b. **Weekly:**

Thoroughly clean chlorinator cabinet, glass parts, floats, metering devices, and other parts in which dirt might interfere with operations or make equipment unsightly. Clean and cover unpainted metal that might corrode with a good film of petrolatum or similar protective compound.

c. **Monthly:**

Check water system. Clean the water strainers and check pressure-reducing valve for proper operation. See that float valves are properly controlling water levels and that there is little or no leakage. See that water flowing to waste is not excessive and that water levels are kept at their proper elevations. See that ejectors have their ample capacities. If they do not, remove and clean with muriatic acid.

d. **Quarterly:**

Disassemble or Operate Hard Rubber Threads, Valves, and Parts. Hard rubber threads or parts on a chlorinator freeze or stick when not operated for long periods, causing breakage when parts are disassembled. To keep the threads from freezing, operate all parts needed to keep chlorinator in service. Do this more often if found necessary. Before reassembling such parts, cover with graphite.

3. Annually:

(1) Overhaul. Disassemble and clean all chlorinator parts thoroughly. Paint chlorinator cabinet inside and out with rust-resistant paint. Carefully examine each chlorinator part. Reassemble and check for proper operation.

(a) The only safe liquids for cleaning chlorine lines are wood alcohol and carbon tetrachloride. After cleaning, allow cleaning solution to evaporate to dryness. Ethyl alcohol or ether must NOT be used as they react with chlorine to form a solid waxy substance which is very difficult to remove. Water reacts with chlorine to form a highly corrosive acid.

(b) Oil or grease react with chlorine to form a bulky, frothy substance. Therefore, they should NOT be used as lubricants at points where they may come in contact with chlorine.

(c) Condensation forming on chlorine cylinder outside walls may corrode scales and other equipment around the cylinder. Guard against such damage by insuring that there is sufficient ventilation around the equipment to keep everything dry. An electric fan may suffice. Do not apply direct heat to dry the cylinder.

(d) It is dangerous to attempt to increase the rate of gas withdrawal by heating chlorine cylinders or containers above the normal room temperature with hot water baths or other means. Inspect regularly to see that chlorine cylinders are not exposed to direct sun heat or near steam or hot water lines or other sources of heat.

(e) Use a new lead gasket each time a valve or tube is connected and when replacing empty chlorine cylinders. Use only ONE lead gasket.

(2) **Examine Solution Tube.** Check tubing for abrasion or cracking that might cause leaks. Inspect tubing for kinks or for mineral deposits restricting discharge. Remove iron or manganese deposits restricting discharge. Remove iron or manganese deposits from diffuser tube by adding ten percent solution of hexameta-phosphate or septa-phosphate to make-up water, at rate of one drop per minute. To add reagent, attach rubber hose to the bottle containing treatment solution, and place a pinch clamp on rubber hose. Invert bottle and adjust pinch clamp for proper feed rate. Continue until deposit is removed. (See figure 1.)

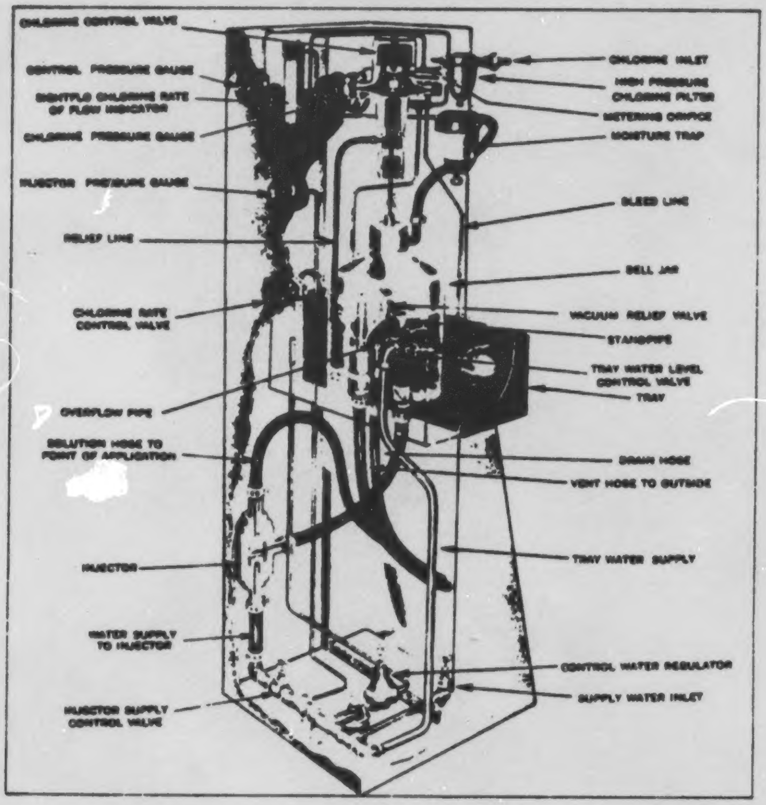

CHLORINE CONTROL VALVE
CONTROL PRESSURE GAUGE
SIGHTFLO CHLORINE RATE OF FLOW INDICATOR
CHLORINE PRESSURE GAUGE
INJECTOR PRESSURE GAUGE
RELIEF LINE
CHLORINE RATE CONTROL VALVE
OVERFLOW PIPE
SOLUTION HOSE TO POINT OF APPLICATION
INJECTOR
WATER SUPPLY TO INJECTOR
INJECTOR SUPPLY CONTROL VALVE
CHLORINE INLET
HIGH PRESSURE CHLORINE FILTER
METERING ORIFICE
MOISTURE TRAP
BLEED LINE
BELL JAR
VACUUM RELIEF VALVE
STANDPIPE
TRAY WATER LEVEL CONTROL VALVE
TRAY
DRAIN HOSE
VENT HOSE TO OUTSIDE
TRAY WATER SUPPLY
CONTROL WATER REGULATOR
SUPPLY WATER INLET

Figure 1. Rear View of Vacuum Type Gas Chlorinator

SOLUTION FEEDERS

Hypochlorinators.

A hypochlorinator is a good example of the chemical solution feeders. Its principle function is to introduce chlorine, in the form of sodium (or calcium) hypochlorite solution into the water supply. The same type unit is sometimes used to feed chemicals (usually a polyphosphate solution) for scale and corrosion control. Hypochlorinators are usually modified positive displacement, piston or diaphragm, mechanical pumps. However, hydraulic displacement hypochlorinators are also used. Hypochlorinators may be manually controlled, semiautomatic, or fully automatic. (See figure 2.)

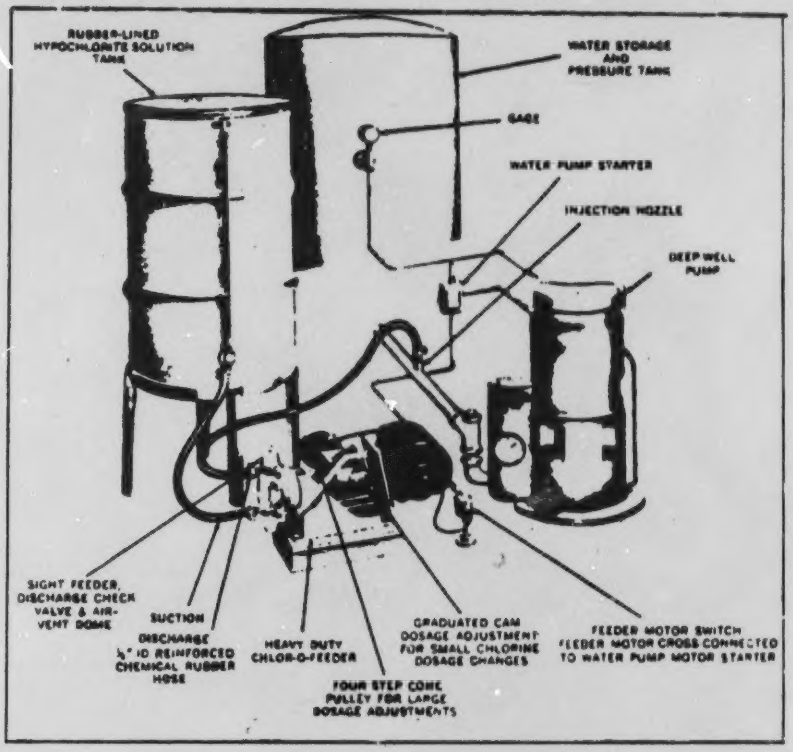

RUBBER-LINED HYPOCHLORITE SOLUTION TANK
WATER STORAGE AND PRESSURE TANK
GAGE
WATER PUMP STARTER
INJECTION NOZZLE
DEEP WELL PUMP
SIGHT FEEDER, DISCHARGE CHECK VALVE & AIR-VENT DOME
SUCTION
DISCHARGE ½" ID REINFORCED CHEMICAL RUBBER HOSE
HEAVY DUTY CHLOR-O-FEEDER
FOUR STEP CONE PULLEY FOR LARGE DOSAGE ADJUSTMENTS
GRADUATED CAM DOSAGE ADJUSTMENT FOR SMALL CHLORINE DOSAGE CHANGES
FEEDER MOTOR SWITCH FEEDER MOTOR CROSS CONNECTED TO WATER PUMP MOTOR STARTER

Figure 2. Motor-Driven Hypochlorinator with Semiautomatic Control

PREVENTIVE MAINTENANCE. (For Pump Type Solution Feeders)

a. Each DAY the equipment is operated:

(1) Check Operation. Inspect sight-feed indicators to insure that solution is being fed.

(2) See that automatic controls start and stop properly.

(3) Make sure there is enough prepared solution.

(4) Check for leaks in piping joints and packing glands.

b.. **Weekly:**

Clean Feeder. Remove and clean glass and plastic parts of sight-feed indicator. Remove white coating caused by hard water in the hypochlorite solution by soaking in five percent solution of muriatic acid.

c. Monthly:

Clean and flush solution tank.

(1) Clean suction strainer and hose.

(2) Disassembl , inspect, and clean solution diaphragm chambers and check valves.

(3) Clean screens and strainers on water-operated feeders.

(4) Exercise all shut-off valves and length-of-stroke controls.

d. Annually:

Overhaul Feeder.

(1) Replace worn parts and packing.

(2) Clean screen in water meter.

(3) Touch up and paint all metal parts.

DRY CHEMICAL FEEDERS

The amounts of dry chemicals added to water must be carefully controlled to insure uniform treatment. The dry chemical feeders may be either manually or automatically controlled. They are accurate, and simple to operate. Those which are automatic have been equipped with flow-measuring devices which proportion the chemical feed to the rate of water flow.

Dry chemical feeders may be of either the volumetric (see figure 3) or the gravimetric loss-in-weight type (see figure 4).

Volumetric feeders displace a preset volume of chemical and will deliver as little as three to four ounces per hour to treat supplies of 200,000 gallons or more daily. Gravimetric feeders displace a definite weight of the chemical and will feed as little as one pound per hour. They are used to treat supplies of 5,000,000 gallons (or more) daily. Chemicals which are commonly fed in the dry condition include lime, soda-ash, alum, and the fluoride compounds.

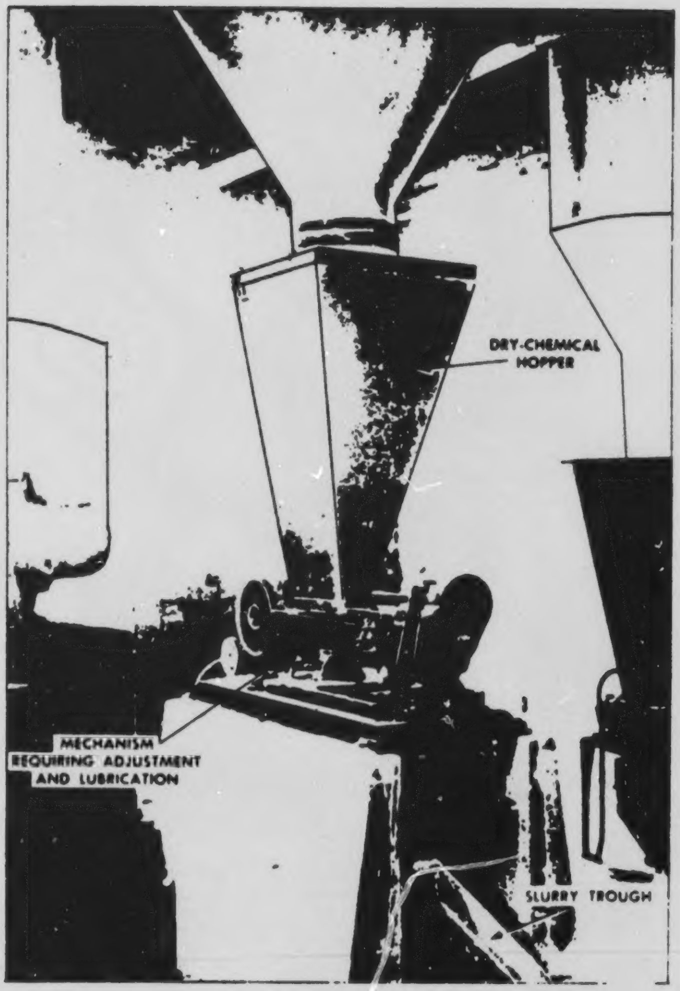

DRY-CHEMICAL HOPPER
MECHANISM REQUIRING ADJUSTMENT AND LUBRICATION
SLURRY TROUGH

Figure 3. Dry Chemical Feeder Installation

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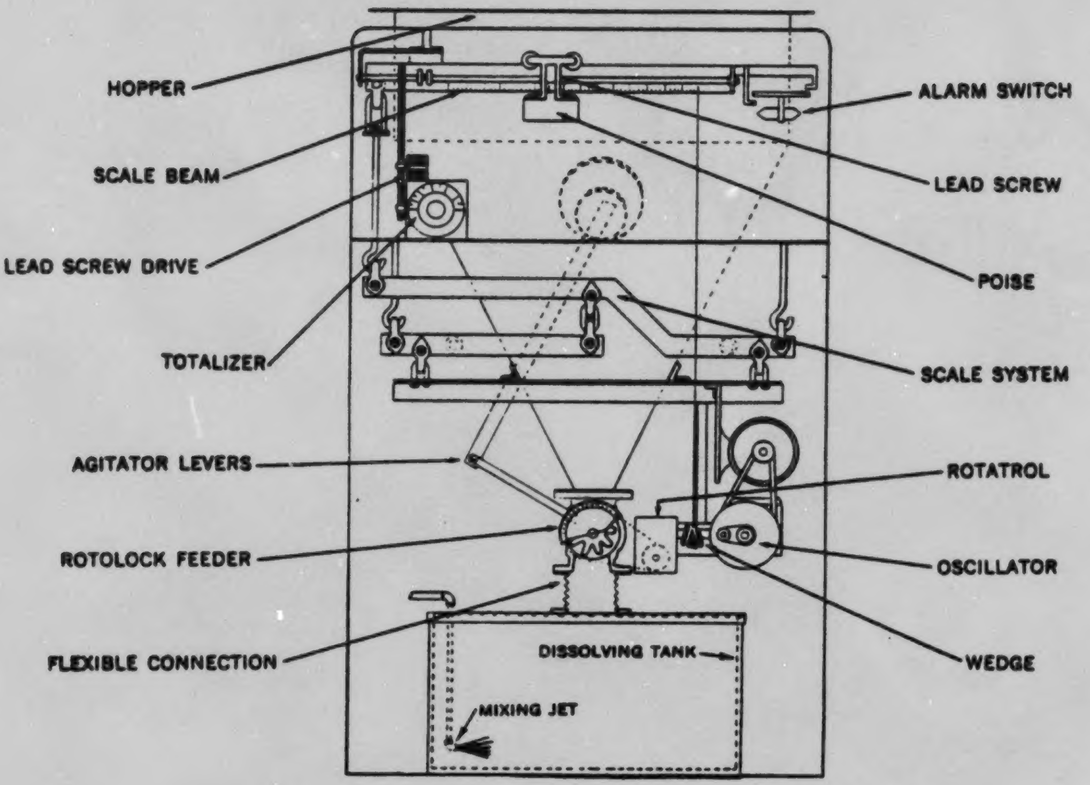
HOPPER
ALARM SWITCH
SCALE BEAM
LEAD SCREW
LEAD SCREW DRIVE
POISE
TOTALIZER
SCALE SYSTEM
AGITATOR LEVERS
ROTATROL
ROTOLOCK FEEDER
OSCILLATOR
FLEXIBLE CONNECTION
DISSOLVING TANK
WEDGE
MIXING JET

Figure 4. Loss-in-Weight Gravimetric Dry Chemical Feeder

PREVENTIVE MAINTENANCE (For Loss-in-weight Type Gravimetric Feeder)

a. Each DAY the equipment is operated:

(1) Clean and Check. Clean feeder, feeder mechanism, and surroundings. See that scale is sensitive to small changes in weight. Whenever feeder is completely empty, determine tare weight, or see if scale indicates zero weight. Look for oil drips and wiring defects. Observe general performance of feeder, changing tare weights of scale. Probe solution tank for sediment or undissolved chemical. Clean tank and improve dissolving conditions if necessary. If chemical feeder is out of service, see that hopper and feed mechanism is empty and that condensation is not causing corrosion or deterioration.

b. Weekly:

Inspect for loose bolts and defective parts. Carefully wipe clean all parts of feeder, inspecting for and repairing loose bolts, leaks, defective parts, and the like.

c. Quarterly:

Service drive mechanism and moving parts according to manufacturer's instructions. See also tables 10 through 14 and section 2 of part H PREVENTIVE MAINTENANCE of AFM 85-13.

d. Annually:

Overhaul Feeder and Scale. Disassemble feeder and clean and inspect all parts for wear or deterioration. Clean and paint feeder inside and out where necessary. Make necessary repairs and properly lubricate all mechanical parts. Service motors and drive mechanisms.

SUMMARY

Most methods of water treatment involve the addition of some type of chemical to the water. To feed these chemicals under controlled conditions, we must utilize chemical feed pumps. The three main types of chemical feeders are gas feeders, solution feeders and dry chemical feeders. The best way to keep the chemical feeders operating properly is by strict adherence to the preventive maintenance schedules, as prescribed in AFM 85-13.

QUESTIONS

1. Why are all chlorine leaks serious?

2. Why should all chlorine valves be operated daily?

3. Why should you never use oil or grease on gas chlorinator valves or fittings?

4. How are chlorine gas leaks located?

5. What is the big disadvantage of a direct feed chlorinating system?

6. How is the easiest way to prevent the valves on a gas chlorinator from sticking?

7. List two chemicals commonly added by means of a solution feeder.

8. Assuming that the chemical feeders are in operating condition, how frequently should they be overhauled?

9. How do you make sure that the solution is being fed by a proportional type solution feeder?

10. What provision is incorporated in dry chemical feeders to insure a continuous, even flow of the chemical out of the hopper? (See figure 3.)

REFERENCE

AFM 85-13, Maintenance and Operation of Water Plants and Systems

MAINTENANCE OF SEWAGE PLANT EQUIPMENT

OBJECTIVE

Upon completion of this unit of instruction, you will be able to identify the inspection and maintenance procedures as performed by the waste plant operator.

INTRODUCTION

Waste treatment equipment is designed to last for many years without mechanical breakdown, but eventually it happens. Worn parts must be replaced, bearings must be lubricated and inspections must be performed to determine when maintenance is needed.

The general standard for maintenance of sewage plant equipment is that they shall be in operating condition at all times. This means you have to recognize equipment failure and know how to repair any defect as rapidly as possible.

Subjects in this unit of instruction will cover maintenance on the following equipment.

- GRIT CHAMBERS
- COMMINUTORS, SHREDDERS AND BAR SCREENS
- SEWAGE LIFT STATIONS
- SEDIMENTATION TANK .
- TRICKLING FILTERS
- DIGESTER AND DIGESTER EQUIPMENT

GRIT CHAMBERS

Equipment used in grit chambers is usually made of heavy cast iron. This is so that the metal will not wear away easily. The scrapers, buckets and shoes are used to aid in the removal of sand and gravel. They will eventually wear down and have to be replaced.

When scrapers, buckets or shoes have to be replaced, the usual method is to pull out a large steel connecting pin so that the worn piece will drop off and a new one can be installed.

If chains are used to drive equipment, the chain sprocket axle will need lubrication. Normally, the grease found in sewage will be enough to keep the chain sufficiently lubricated.

Some grit chamber equipment has zerk connections for grease guns and some have oil reservoirs that lubricate the bearing. If these are serviced regularly, the equipment will last many years.

Most grit chambers use electrically-powered equipment. The inspection and cleaning of motors are your responsibility. Since you must keep the equipment operating at all times, you must oil the bearings, and keep trash, dirt and rags from the motor. Never wash a motor to clean it. Water will cause the motor to short circuit and burn out.

COMMINUTORS, SHREDDERS AND BAR SCREENS

Comminutors and Shredders

Comminutors and shredders are both used to grind or break up large solids. In either case there are wheels or drums that turn on an axle. These axles have lubricating points which must be oiled at recommended intervals, perhaps daily.

Comminutors and shredders are powered by an electric motor (figure 1).

Electric motors must be inspected occasionally for overheating, noise and lack of lubrication. The motor drives the wheel or drum to which is attached the cutting teeth or blades. Sand and grit eventually dull the cutters. During an inspection if the cutters are found dull, a new or resharpened set must be installed.

Bar Screens. Bar screens are usually heavy cast-iron gratings that stop large floating materials. Maintenance is seldom required on the screen itself; however, if the screen has a mechanical scraper, then the gears, bearings, drive chains, and electric motor require servicing. Lubrication of these parts is simple, but very important.

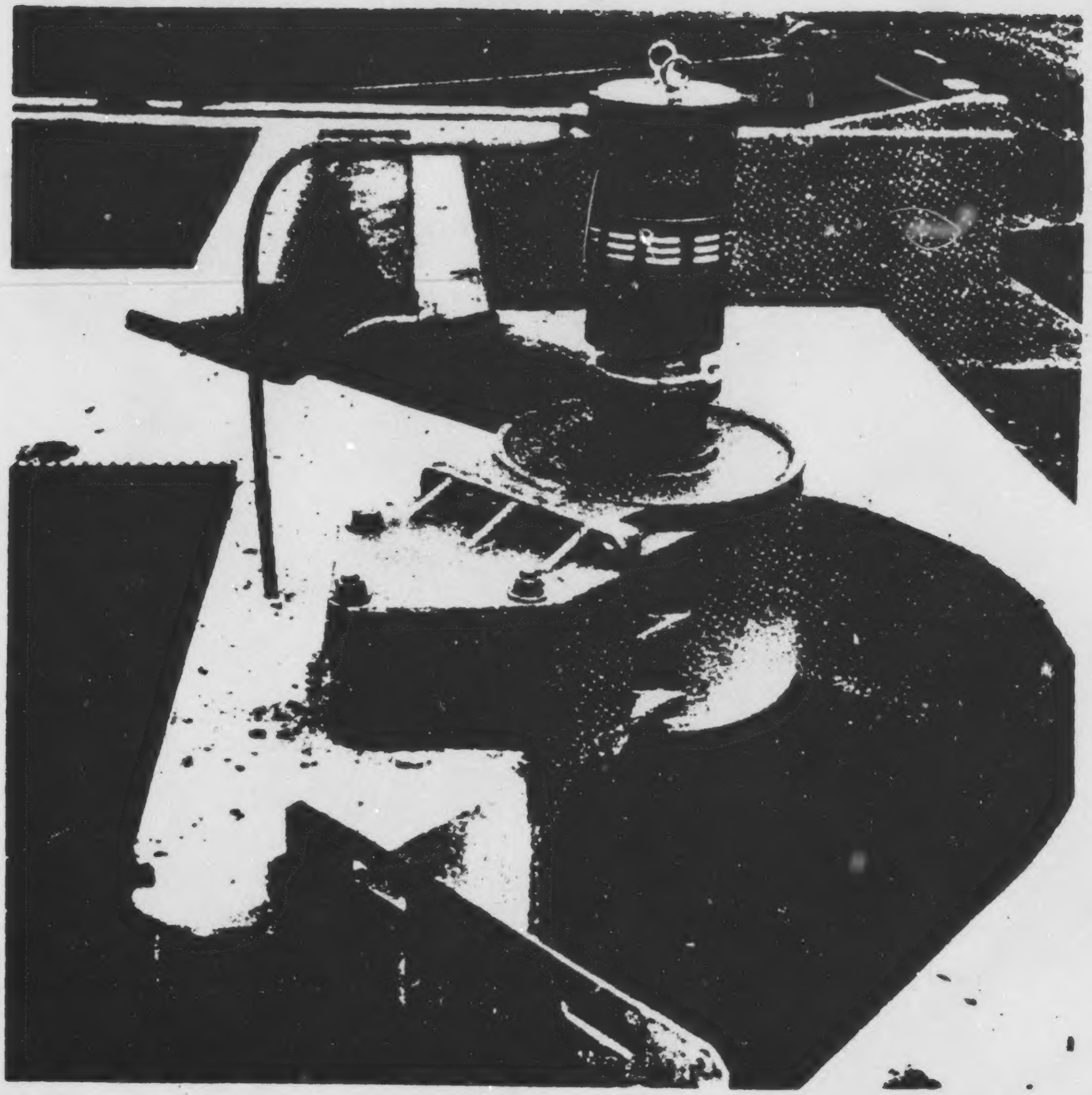

Figure 1. Comminutor Installation

SEWAGE LIFT STATIONS

Lift Stations

Lift stations are used where gravity flow is not possible. The pumps used in a lift station must lift sewage and water from a low area underground to a higher point so the waste can start its slow downhill travel again. For this reason, the pumps must handle large quantities at low velocities. The pumps must also have large openings to allow large solids to pass through them.

Pump Maintenance

Pumps used in a sewage lift station are of heavy-duty construction. They will very seldom require maintenance; however, you will need to inspect them to see if rags or strings have been caught in the pump. Normal servicing such as lubrication and tightening packing glands will be required.

Building Maintenance

Sewage lift stations are housed in a concrete or brick building. The walls of the building may serve to hold the incoming sewage. When the depth of sewage reaches a certain point, the pump will automatically come on and pump the level down.

Maintenance on the building can actually be divided into three separate areas: ceilings and upper walls, lower walls and then the floor.

The ceiling, upper walls, windows and overhead pipes stay wet all the time from condensation. Sewage gases create an acid condition in the humidity and this acid eats at the masonry in the building, it corrodes the metal in the pipes and windows.

Proper ventilation helps get rid of the moisture and a good paint job on the pipes and windows helps protect them from rust.

The second area of building maintenance is the cleaning of the walls that is below the sewage level. Thick layers of grease builds up on the walls and has to be scraped and hosed down. Accumulation of grease creates nuisance odors and unsightliness.

The third area of building maintenance is the cleaning of the floor. Grit, stones, grease and heavy materials have to be cleaned out. This job is usually done manually as the amount to be hauled out is small.

SEDIMENTATION TANK

There are many types of sedimentation tanks, however, they all require inspections and maintenance. Some waste plants have installed new sedimentation tanks, and maintenance can best be performed by following the manufacturer's instructions.

Older plants have equipment listed in AFM 85-14. When performing other than very simple maintenance, a set of directions should be followed.

To be a good maintenance man, you must know the machinery and the names of the parts that make up a complete unit. It is not within the scope of this course to teach the many small components of equipment; therefore, you will have to follow printed directions in much of your work. Directions will take the form such as shown in the following paragraphs.

Inspection and Lubrication

Check oil level in speed reducers, oil baths and gear cases, and see that oil is clean and of good body. Drain a small amount of oil from bottom of gear casings and oil baths to eliminate any accumulated water. If oil is gritty or lacks body and oiliness, change it promptly.

Lubricate countershaft bearings with a small amount of grease forced through each of the fittings. (Do not overlubricate.) Excess grease enters worm gear housing and mixes with oil producing a heavy oil that will not flow properly around ball bearings and worm gears. Too much grease may force shaft seals out of place.

Do not lubricate bearings submerged in sewage except when unit is taken out of service and emptied. Before starting equipment in which bearings have dried, lubricate with light oil. Inspect bearings to see that they are anchored securely. Grease pillow block bearings until grease squeezes out at the ends.

Small bearing points use Oilite bushings of porous bronze, which soak up and retain a large amount of oil. These bushings do not have oil holes as oil penetrates them readily. To lubricate, put a few drops of light oil in the cups to keep bushing saturated. Some bushings are made of graphitized bronze and require no further lubrication.

Roller chains are lubricated by two methods. If the chain is totally enclosed, it is lubricated by dipping into an oil bath. If the bottom of the chain guard is open, the chain is lubricated by squirting or brushing the lubricant on the chain.

Chains usually deteriorate when not used for long periods. If chain is to be idle long, remove it, coat it with a heavy lubricant and store it until needed.

Replace worn or damaged links promptly to prevent unnecessary wear on adjacent links and sprockets.

Tighten chains, if loose, by removing links and/or proper positioning of takeup shafts or drive equipment. In final tanks where takeups are not used, place chains around sprockets and remove links until chains reach desired tension.

Check drive cable for amount of slack and if it is excessive, correct it by adjusting takeups at opposite end from drive unit. In general, a cable which is slack, rather than too tight, will minimize wear on cable and mechanism. On cables that are not submerged during operation, make necessary adjustments to compensate for difference in cable length caused by winter and summer temperature changes.

Inspect wood flights for cracks and make sure they are securely fastened on attachments. If bolts are loose, tighten them and peen end of bolt so nuts cannot work loose. Weld stellite to steel wearing shoes when they become worn, to prolong their usefulness.

Before starting collector equipment on some units in extremely cold weather, make sure that ice has not frozen chain to sprocket. If chain has frozen to sprocket, remove guard and pry chain loose with a bar.

Flush Sludge Line

Back-blow sludge line with compressed air or high-pressure water. Protect water connection against cross connection hazards. See that sludge or foreign matter is not plugging sludge line.

Check Tanks for Sludge Overload

If sludge overload is built up, open discharge while machine is running. If the overload on the motor is so great that heater coils in starter box opens the switch and stops the machine, drain the tank and sluice out the sludge.

CAUTIONS. When the overload alarm rings the bell or stops the motor, do not try to keep the equipment running. Instead, find the source of trouble and remove it immediately. Do not start the equipment with a load of sludge in the tank. Do not tamper with the overload alarm switch adjustments just to keep the machine operating.

If a foreign object drops into the tank, stop the machine and try to remove the object, if necessary, cutting off influent to stop sludge accumulation. If the object cannot be removed with tank filled, drain the tank and remove the object before resuming operation.

TRICKLING FILTER

Lubrication procedures already given can be applied to trickling filter equipment. Inspection and maintenance procedures for trickling filter equipment will be discussed in the following paragraphs.

Inspection and Maintenance

Inspect spreader jets, splash plates or orifices and clean them if necessary. Before replacing orifice cover, apply grease or Tite Seal compound (furnished with some equipment) to threads to prevent leakage.

Some distribution arms have gates on the end of the arms which can be opened after cleaning the orifices to flush out the distributor arms.

Adjust turnbuckles or vertical guy rods slightly when necessary during hot weather to prevent the distributor arms from coming too close to the bed surface. If spreader jets are used, operate them with hinged flap down to distribute sewage more evenly. In cold weather, adjust turnbuckles as required to keep arms level. In adjusting, balance all arms exactly by measuring to a mark on filter wall.

Check to see that distributor arms and branches are level. If arms and branches are dismantled from center column, replace them in their original position because no two arms or branches are alike.

Check the distribution of sewage over the filter bed. Inadequate coverage of filter media results when distribution is poor. Overdosing one portion of filter may cause ponding of that portion only, as it prevents intermittent penetration of air and deprives bacteria of the necessary oxygen supply. The outer part of the distribution arm sweeps a larger area so make sure a proportionately greater quantity of sewage is discharged by that part of the arm.

Inspect the elbows that flush the tank wall. The function of these small elbows in the dump gate is to control the development of filter fly larvae by directing a stream at the tank wall. Clean the elbows and check the flushing action. If necessary, turn elbows to direct stream at different portion of wall or change their size.

Mercury Seal

Distributors equipped with a mercury seal have an annular mercury well between the stationary column and the rotating section to prevent water from getting to the support bearing. If the seal is accidentally blown, mercury is caught in a trap below the manifold. When draining seal or trap, catch mercury in a glass, earthenware, enameled or steel container. Never use galvanized or tin container as mercury mixes with solder, destroying the joints.

Cleaning Mercury

Wash mercury by placing in container with a tight lid, adding water and shaking it vigorously, then pour off the water. Repeat until mercury is clean.

To remove any grit, place mercury on dampened chamois skin, water passes through chamois and grit particles adhere to chamois when mercury is poured off. Repeat this procedure several times if necessary.

If the mercury has become badly sludged, dissolve the sludge with kerosene, then treat it with a 50% concentrated solution of nitric acid and wash with a sodium bicarbonate solution to neutralize the acid. After two or three washings in water, the mercury is ready for use.

DIGESTER AND DIGESTER EQUIPMENT

In an earlier block of instruction, the purpose and operation of digesters were thoroughly discussed; therefore, this section will be devoted to maintenance only.

There are many makes and designs of digesters and it is beyond the scope of this course to teach maintenance on every type of digester. A study on general maintenance will enable you to adapt your knowledge to any type of digester.

Structure Maintenance

Most digesters have a concrete exterior and it must be inspected for cement chalking. Chalking is a powder condition usually caused by chemical attack on the concrete. To stop chalking, the concrete should be wire-brushed or sandblasted down to hard concrete and then a coat of paint applied.

It has been found in hot climates that light-colored paints increase the efficiency of digesters because of the cooling effect. Dark-colored paints cause the digester to warm up and become overactive.

All exterior metal pipes and fittings should be cleaned of rust, then primed with a good metal primer and lastly covered with an exterior grade of industrial paint.

The interior walls and floor of a digester will require little or no maintenance. The interior should be inspected for stress, cracking and breaks and repaired as required.

Metal parts on the underside of a floating cover digester should be inspected for rust. If the digester has been in operation for any length of time, there will be a lard-like coating on the metal parts. Do not remove this coating as it protects the metal from corrosion.

Cover Maintenance

Very little maintenance is required on the outside of the cover on any type of digester. When a fall in gas production is noted, it normally indicates a leak in the cover. Flooding the cover with water will allow you to locate the leak.

Floating covers are held in place by rollers and rails. When the tank has been emptied, the cover is in the down position and the rollers and rails can be inspected for breaks and corrosion.

Pipeline Maintenance

Exterior piping on a digester requires no special inspections, other than prevention of corrosion. Proper painting will prevent rust problems.

Interior piping becomes lard-coated and corrosion is no problem. A stopped-up pipe can usually be unplugged by tying into a high-pressure water supply and back-flushing the pipe.

Pressure Relief Assembly Maintenance

The pressure relief assembly and waste gas flame trap are usually one unit mounted in the center of the top of the digester (see figure 2).

The pressure relief assembly holds a preset amount of gas pressure within the digester. Maintenance on this unit includes checking it for operation and inspecting the leather diaphragm for cracks.

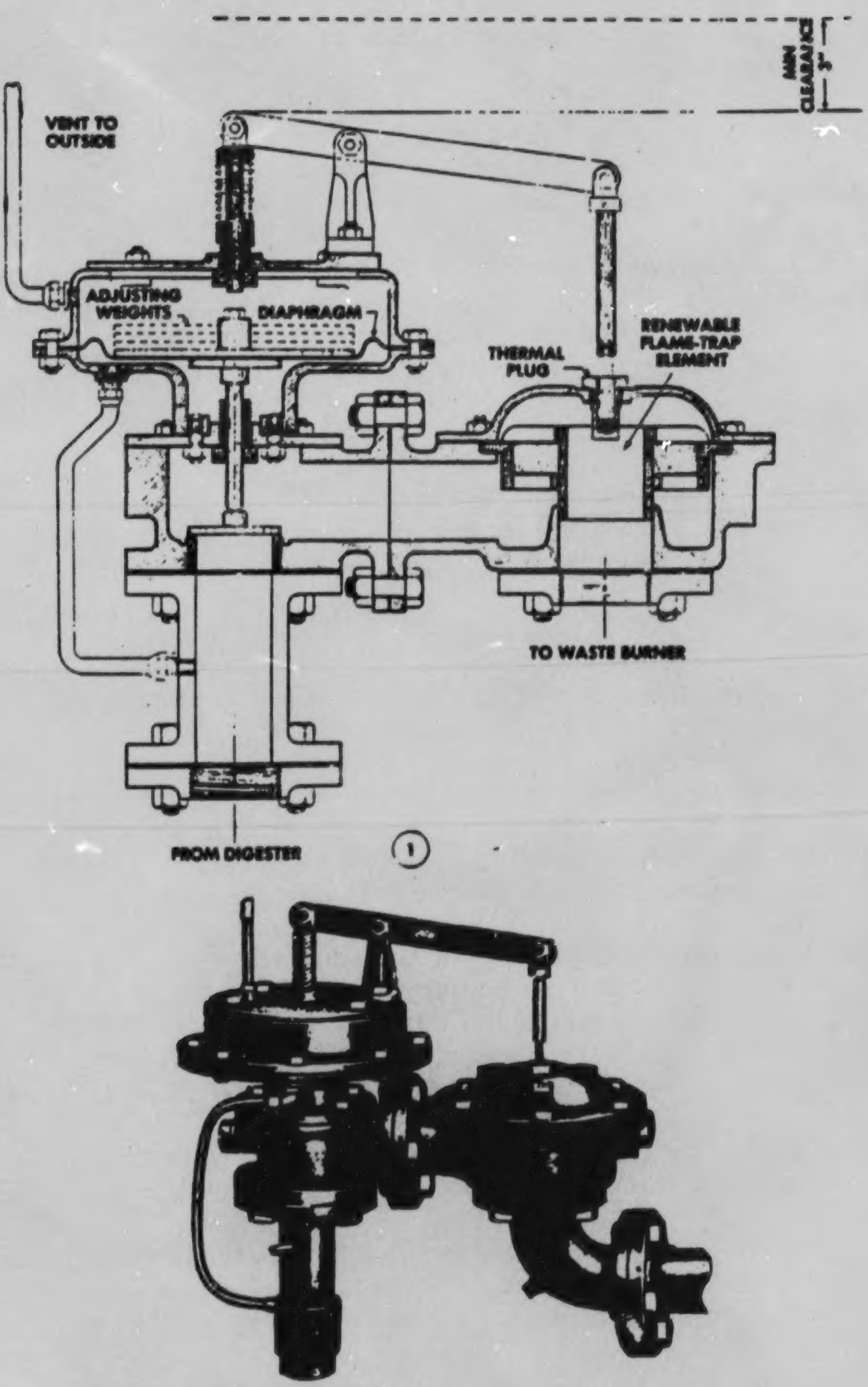
MIN CLEARANCE 3"
VENT TO OUTSIDE
ADJUSTING WEIGHTS
DIAPHRAGM
THERMAL PLUG
RENEWABLE FLAME-TRAP ELEMENT
TO WASTE BURNER
FROM DIGESTER
①

Figure 2. Pressure-Relief Waste-Gas Flame Trap

SUMMARY

Maintenance of sewage treatment equipment is not an everyday job; however, inspection of the equipment is a constant job.

Anytime you look at the grit chamber, bar screen or comminutor, you are observing for operation, unusual noises or anything out of the ordinary.

Sewage treatment equipment must be kept in good operating condition and occasionally cleaned. Exposed iron must be protected from corrosion, worn parts removed and replaced, tanks occasionally drained and hosed down.

Good maintenance and regular inspections prevent sewage plants from becoming a worn-out health hazard.

QUESTIONS

1. What is the general standard for sewage plant maintenance?
2. Name two methods used to remove grit from a grit chamber.
3. Which two units use cutting teeth in their operation?
4. What is most likely the cause of pump stoppage in a lift station?
5. In a sewage lift station, where would corrosion be most apt to occur?
6. What material is usually found as a coating on the walls of a lift station?
7. What two methods are suggested for tightening chains on sewage plant equipment?
8. If the arms of a trickling filter are not level, what might occur to the filter bed?
9. How can a gas leak in the top of a digester be easily located?
10. What flexible component within a digester pressure relief valve needs inspection for cracks?

REFERENCES

1. AFM 85-14, Maintenance and Operation of Sewage and Industrial Waste Plants and Systems

2. TM 5-666, Sewage Treatment Plants and Sewer Systems at Fixed Installations.

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PUMP MAINTENANCE

OBJECTIVES

The objectives of this study guide are to acquaint you with the types of pumps used in water and waste systems, to give you an idea of the pump maintenance which is required, and to give you a knowledge of the major parts of a centrifugal pump.

INTRODUCTION

Pumps of different design and sizes will be required to pump water from the source to the water treatment plant. After treatment, additional pumping may be required to force the water into the mains or into the storage reserviors. Many types of pumps are required to operate a sewage system at maximum efficiency.

The information will be presented under the following headings:

- TYPES OF PUMPS AND THEIR INSPECTION & MAINTENANCE REQUIREMENTS
- GENERAL INSPECTION ITEMS FOR PUMPS
- MAJOR PARTS & COMPONENTS OF A CENTRIFUGAL PUMP

You are encouraged to read and become familiar with the information which is contained in the references listed at the end of this study guide.

TYPES OF PUMPS AND THEIR INSPECTION AND MAINTENANCE REQUIREMENTS

Pumps used in the water supply system are classified according to both design and use, and they include five major types. The major types are: velocity, displacement, turbine, air lift, and ejection.

Velocity Pumps

Velocity pumps include centrifugal (vertical or horizontal), mixed flow, and axielflow pumps.

CENTRIFUGAL PUMPS. A centrifugal pump consists of a rotating impeller, an impeller casing, and a flow receiving chamber. The impeller is a radial group of vanes curved backward from the direction of rotation and mounted either directly on the shaft or on a single disk (open impeller). The impeller and impeller casing are usually enclosed by a flow receiving chamber with a volute or progressively expanding spiral passage. In some types, the flow receiving chamber is an annular passage to the shaft. In either type the cross-sectional area increases toward the point of discharge. Centrifugal pumps have many forms, such as single or double suction, and single or multiple stages. A horizontal, double suction, volute pump is illustrated in figure 1.

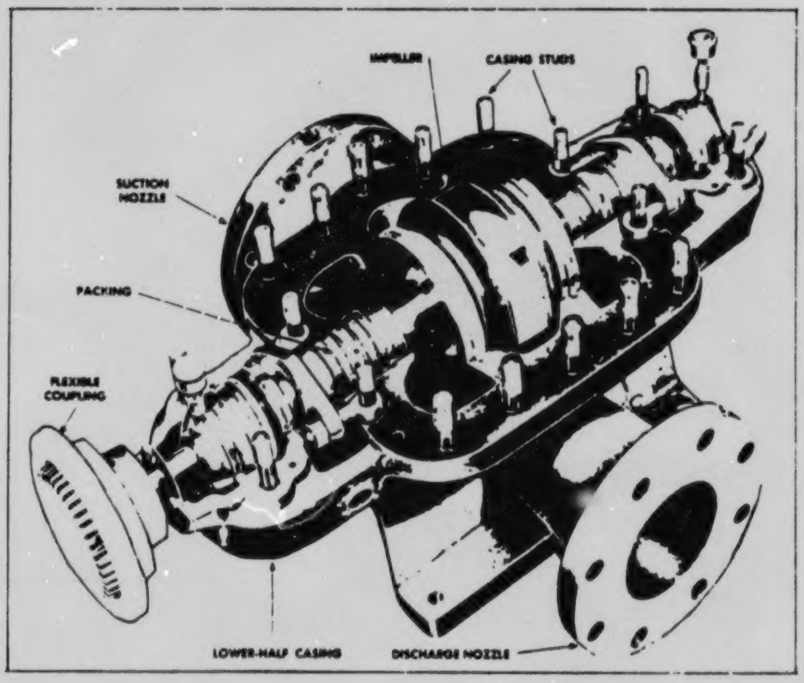


Figure 1. Horizontal Split-Case Double-Suction Volute Centrifugal Pump

Centrifugal pumps are the most commonly used type of pump in water systems because they are well adapted to electric drives and a wide variety of operating conditions. For reliable operation, suction head should not exceed 15 feet. Multiple stage centrifugal pumps are used where high discharge pressures are required.

Operating Precautions. By observing these precautions, you will eliminate many of the commonly encountered problems with centrifugal pumps.

(1) Fill centrifugal pumps with water before starting them. This procedure, known as priming, lubricates close-fitting sealing rings and packing, and insures that the pump is free of air or air bubbles.

(2) Make certain that suction piping is airtight.

(3) To operate at design capacity, keep speed of rotation and total head as close to design figures as possible. When total head is less than that for which the pump is designed, the pump motor may overload and overheat.

MIXED FLOW PUMPS. Mixed flow pumps are similar to centrifugal pumps, with the exception that the impeller discharges water in a patch inclined on the axis of the shaft. The flow receiving chamber is either a volute passage or an expanding discharge pipe similar to that of an axial flow pump (see figure 2).

Operating Precautions. Operating precautions are the same as for centrifugal pumps.

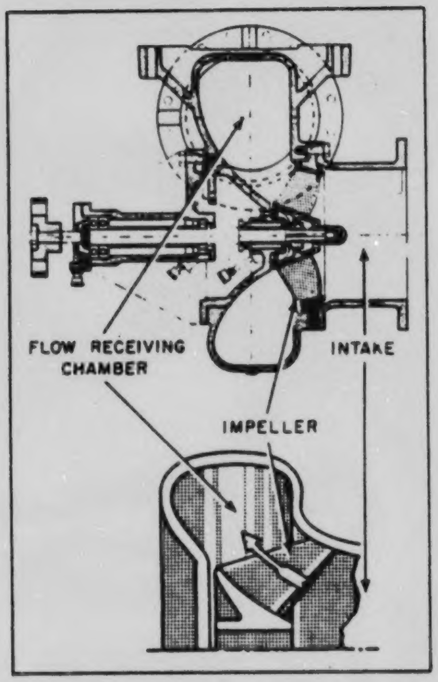


Figure 2. Mixed-Flow Pumps

AXIAL-FLOW PUMPS. Axial-flow pumps, also known as propeller or screw pumps, consist of a rotating impeller resembling the propeller of a ship, a cylindrical casing, and a slightly expanding annular discharge passage, see figure 3. Axial-flow pumps are suited only for very low head (5 to 30 feet), high capacity service. Their principal use is for industrial irrigation and storm water pumping.

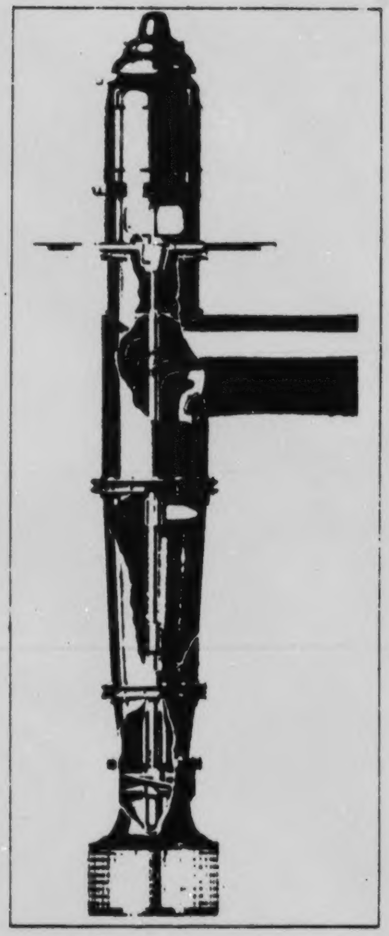


Figure 3. Vertical Axial-Flow Pump with Screw Type Impeller

Displacement Pumps

Displacement pumps may be reciprocating or rotary (each of which may be vertical or horizontal). Reciprocating displacement pumps include piston, plunger, and diaphragm pumps. Rotary displacement pumps include the helical rotor but not the rotating types such as centrifugal and axiel-flow pumps.

RECIPROCATING PUMPS. A reciprocating well pump consists of the following major parts: a powerhead or jack located above ground, a pump cylinder submerged in the well, and a drop pipe which houses the rods and supports the cylinder and foot valves and conduts the water to the top of the well. The jack which is driven by an electric motor or gasoline engine through gears or a belt imparts reciprocating motion to the plunger. Reciprocating well pumps may have single, double, or triple stroke operation, see figure 4.

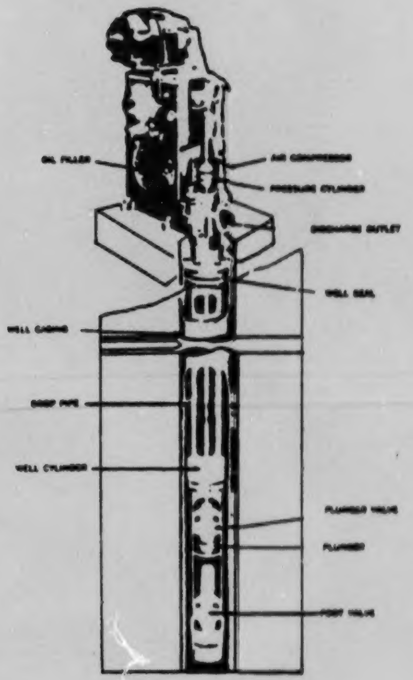
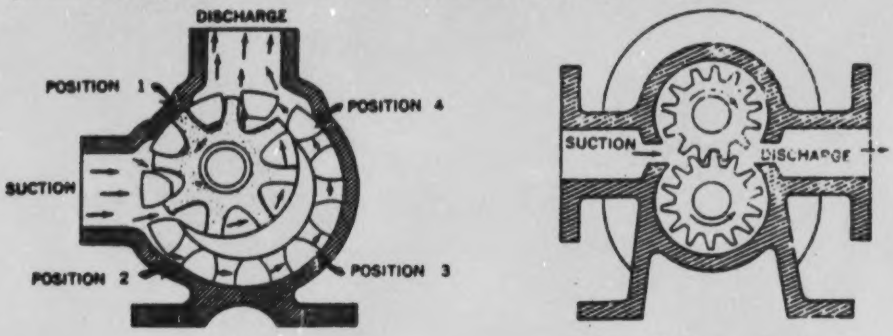

OIL FILLER
AIR COMPRESSOR
PRESSURE CYLINDER
DISCHARGE OUTLET
WELL SEAL
WELL CASING
DROP PIPE
WELL CYLINDER
PLUNGER VALVE
PLUNGER
FOOT VALVE

Figure 4. Reciprocating Well Pump

Reciprocating well pumps are normally used for small wells or moderate depth with capacities less than 25 g.p.m. They are used at such locations as firing ranges, bivouac areas, and other small facilities not served by the installation water supply.

Reciprocating Pump Maintenance. The delivery per stroke should be at least 90 percent of the columetric displacement of the pump. (Area of plunger times length of stroke). When delivery falls below 50 percent of the voltumetric displacement, or if water supplied is below installation water requirements, remove pump from the well and examine valves and cup leathers. Note: Consult the manufacturer's instructions for picking up foot-valve and additional maintenance procedures.

ROTARY PUMPS. A rotary pump consists of a stationary casing containing one or more rotating elements. Figure 5 shows four of the many types of rotary pumps, all with the same general principal of operation. Rotary pumps are used in water works for priming larger pumps and for limited special applications.

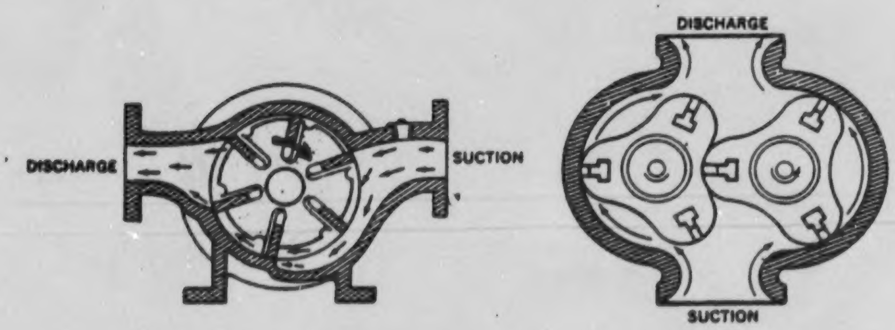


INTERNAL-GEAR TYPE

A

SPUR OR EXTERNAL-GEAR TYPE

B



SLIDING-VANE TYPE

C

THREE-LOBE TYPE

D

Figure 5. Several Types of Rotary Pumps

Rotary Pump Maintenance. The pump should be disassembled and cleaned thoroughly on the inside and outside. If the interior of the pump is subject to rusting, paint the interior surface with a suitable underwater paint, or other effective coating. (Areas not subject to close tolerances only). Check all clearances according to manufacturer's instructions. Check packing assembly and repack as needed.

PISTON TYPE PUMPS. A piston type pump has a piston which fits tightly and operates inside a cylinder. The pump may be direct or belt driven, single or double acting. Pump troubles can generally be traced to poor packing, fouled water cylinders, worn valves, or to faulty condition outside the pump itself, see figure 6.

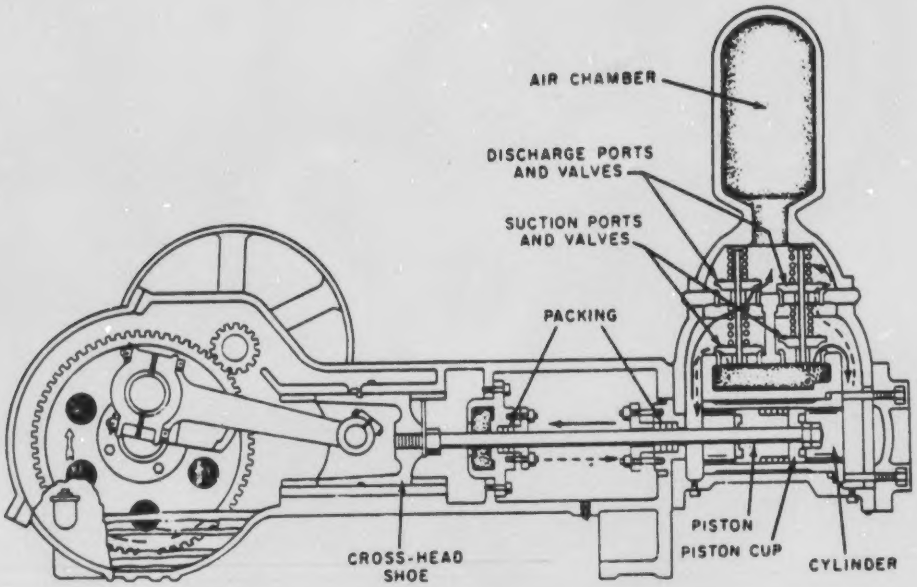

AIR CHAMBER
DISCHARGE PORTS AND VALVES
SUCTION PORTS AND VALVES
PACKING
CROSS-HEAD SHOE
PISTON
PISTON CUP
CYLINDER

Figure 6. Belt-Driven Self-Oiling Piston Pump, Single-Cylinder, Double-Acting Type

Piston Type Pump Maintenance. Dismantle and thoroughly inspect the pump. Remove and examine all valves, valve seats, and all valve springs. Remove all old packing. Examine plunger or rod for scoring or grooving. Repack and check alignment. Clean interior and exterior of pump. Paint interior iron with suitable underwater paint or protective coating. (Areas not subject to close tolerances only).

Turbine Pumps

The turbine pump has a disk-shaped rotating impeller with many small radial vanes near the edge. The inside of the casing is channeled around the impeller vanes, providing water passage from suction port to discharge port, see figure 7.

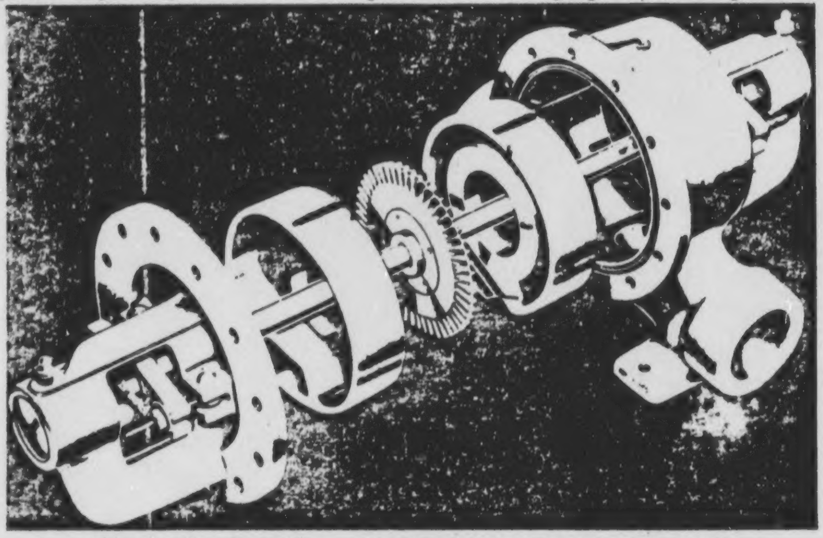


Figure 7. Impeller and Housing of Turbine Type Pump

Turbine pumps are used for high head, low capacity service. A common use is for booster pumps for solution feed chlorinators.

TURBINE WELL PUMPS. A turbine well pump is a small diameter, multistage centrifugal or mixed flow pump suspended in the well. The well diameter limits impeller diameter. As a result, this limits the head produced in a single stage; multiple stages are provided to create the head and capacity desired. Weight of rotating parts is usually carried by the thrust bearing in the pump head. Pump and intermediate bearings may be either oil or water lubricated. From a sanitary point of view, water lubrication of pump bearings in any well is preferable. Contaminated lubricating oil has been responsible for contaminating well water (see figure 8).

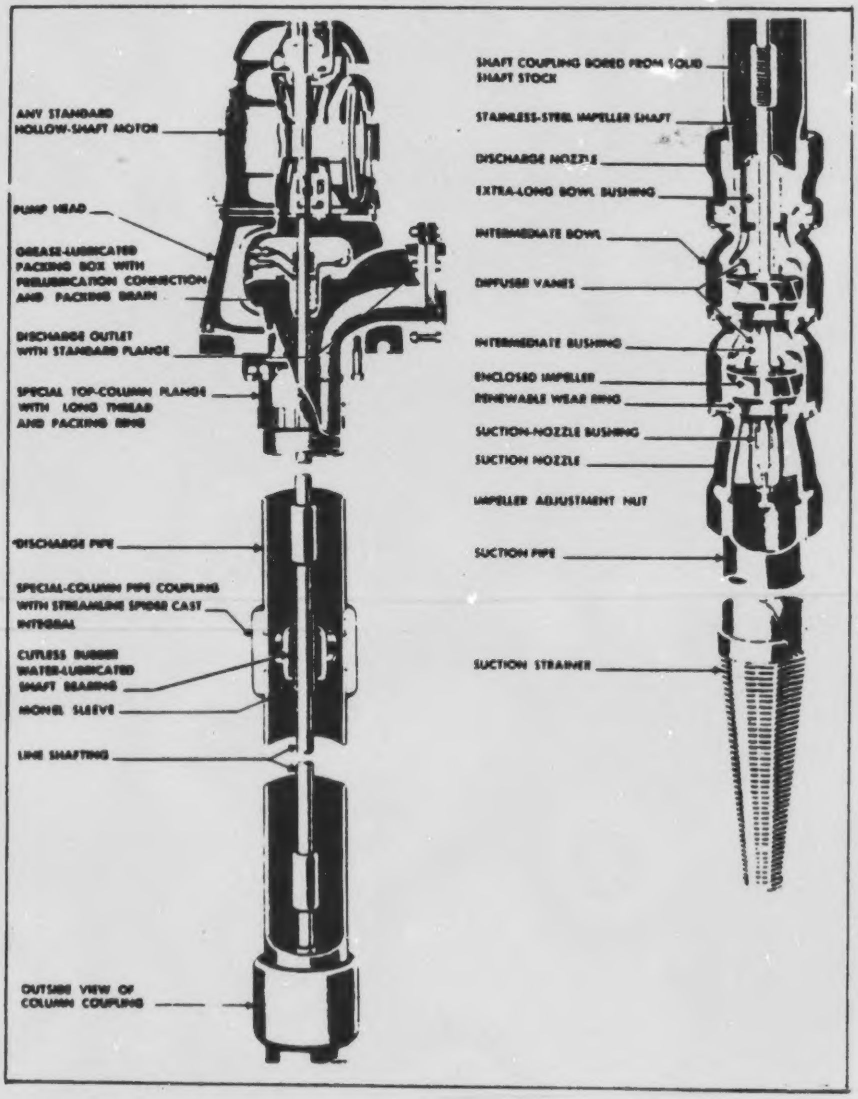

ANY STANDARD HOLLOW-SHAFT MOTOR
PUMP HEAD
GREASE-LUBRICATED PACKING BOX WITH PRELUBRICATION CONNECTION AND PACKING DRAIN
DISCHARGE OUTLET WITH STANDARD FLANGE
SPECIAL TOP-COLUMN FLANGE WITH LONG THREAD AND PACKING RING
DISCHARGE PIPE
SPECIAL-COLUMN PIPE COUPLING WITH STREAMLINE SPIDER CAST INTEGRAL
CUTLESS RUBBER WATER-LUBRICATED SHAFT BEARING
MONEL SLEEVE
LINE SHAFTING
OUTSIDE VIEW OF COLUMN COUPLING
SHAFT COUPLING BORED FROM SOLID SHAFT STOCK
STAINLESS-STEEL IMPELLER SHAFT
DISCHARGE NOZZLE
EXTRA-LONG BOWL BUSHING
INTERMEDIATE BOWL
DIFFUSER VANES
INTERMEDIATE BUSHING
ENCLOSED IMPELLER
RENEWABLE WEAR RING
SUCTION-NOZZLE BUSHING
SUCTION NOZZLE
IMPELLER ADJUSTMENT NUT
SUCTION PIPE
SUCTION STRAINER

Figure 8. Water Lubricated Vertical Turbine Pump

Turbine well pumps are used in deep wells of 4 inches and larger in diameter. They may also be used as booster pumps.

Turbine Pump Maintenance. With pump assembled, check clearance of impeller between liners and check movement of shaft endways.

NOTE: Most pumps of this type have an adjustment for centering the impeller.

Adjust clearance equally for both sides of the impeller. If clearance is not 0.010" - 0.012", replace the impeller and liners. Coat the interior of the pump with a suitable underwater paint or protective material. (Areas not subject to close tolerances only).

Air Lift Pumps.

Air lift is a method of raising water by compressed air. The principle of operation is shown in figure 9. If the U-tube is filled with water, the water stands at height H in both legs of the tube. When compressed air is introduced as shown in the figure, a mixture of air and water is formed in one leg. The solid column of water W weighs more than the air-water column P, forcing it over the top of the U-tube. The pressure required for pumping depends entirely on submergence; the height to which water must be elevated has no effect. The starting pressure is always greater than the working pressure after the well pumping level is reached. If drawdown is excessive, the high starting pressure may require an auxiliary compressor connected in series with the main compressor and receiver. The auxiliary compressor is operated only during starting.

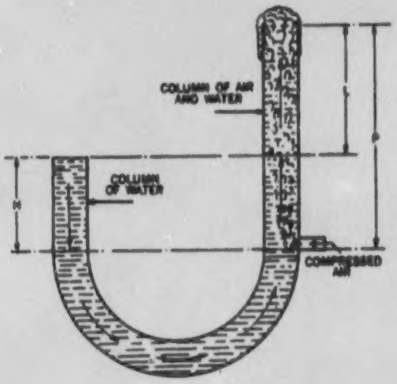


Figure 9. Principle of Air Lift

Air lift pumps are useful for groups of wells discharging to ground storage and served by a single compressor installation. Lower efficiency is offset by lack of maintenance problems, especially in crooked wells and those producing sand. They are particularly adapted for emergency deep well pumping, using a portable air compressor for power. Air lift pumps cannot be used for direct pumping to a distribution system or for horizontal transmission of water. The added oxygen in air lifted supplies tends to make water more corrosive.

Air Lift Pump Maintenance. Check for air contamination. Make sure that there are no cross connections in air system by which contaminated air or water may enter a well. Examine the water sample from the well for presence of oil which may come from compressed air. Examine compressor for oil pumping if oil appears in the sample.

Ejector Well Pumps

An ejector well pump consists of a centrifugal type sinble impeller pump above ground and a stationary ejector assembly in the well. The ejector assembly is made up of a nozzle within a tube which tapers down to a narrow throat opening at the top of the nozzle (see figure 10).

Ejector well pumps are suitable for small wells within limited ranges of depth. Because there are no moving parts in the well, they can be installed away from or directly over a well.

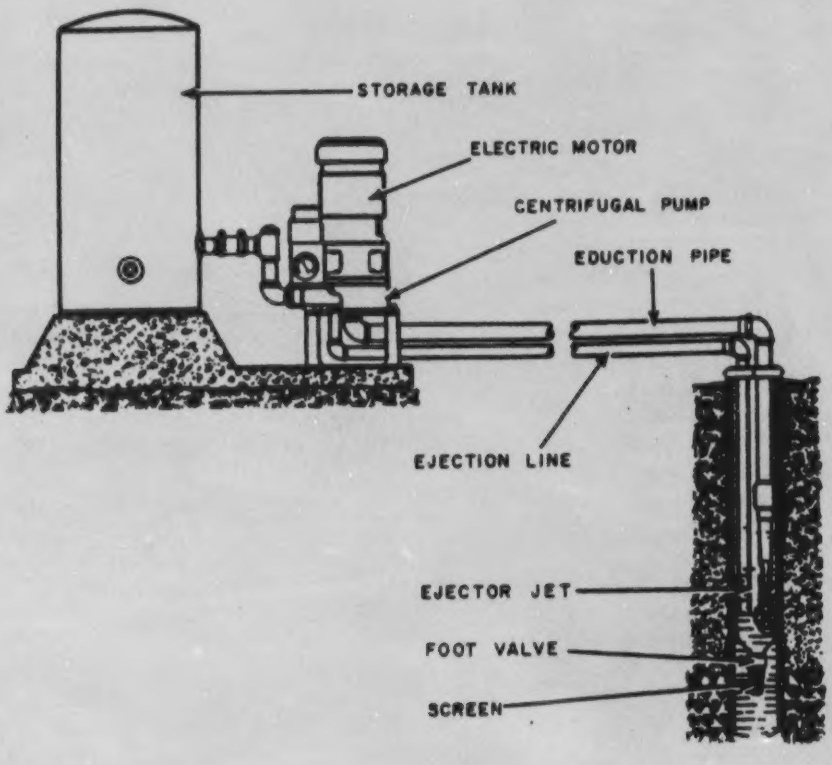

STORAGE TANK
ELECTRIC MOTOR
CENTRIFUGAL PUMP
EDUCTION PIPE
EJECTION LINE
EJECTOR JET
FOOT VALVE
SCREEN

Figure 10. Ejector Pump Installed Away From Well

Ejector Pump Maintenance. When the ejector, foot valve, and screen are removed from the well, examine all parts for corrosion. Check the size of the nozzle and ejector throat. If there is evidence of wear, consult the manufacturer's instructions for proper diameters. Check the foot valve for leakage, and replace seat, replace valve, or reseat if necessary. Renew strainer if necessary.

GENERAL INSPECTION ITEMS FOR PUMPS

Pumping equipment normally operates with little trouble if it is properly maintained in accordance with instructions. Pumps handling chemicals or abrasive solutions may require more frequent inspections and preventive maintenance operations than shown, and schedules should be modified on the basis of actual operating experience.

Listed below are general inspection items for pump:

1. Inspect driving equipment, electric motors, etc.
2. Check operating conditions. To maintain a pump properly, operators must learn to recognize the normal sounds and operating conditions of a properly running pump and to investigate any change in these sounds or operating conditions.
3. Check wearing or sealing rings. These rings seal discharge water from suction water in rotating pumps. Excessive leakage seriously affects pump efficiency.
4. Check pump for cavitation. Cavitation generally results from improper pump design or improper use of the pump. Cavitation severely pits the impeller, and can usually be corrected by lowering the pump and reducing the suction lift.
5. Test performance of pump. Determine the pump's efficiency, using accurate instruments and gauges. Data obtained from the tests helps in controlling operating costs and locating defects in equipment or its use. Compare the pump test data with the manufacturer's specifications and investigate any wide differences.
6. Check pump packing. Pumps with rotating or reciprocating shafts require periodic packing to prevent excessive leakage. The packing can be adjusted to reduce the leakage.
7. Lubricate bearings. Where oil lubricated, use the specified amount and type of lubricants. Where water lubricated, insure that the system is functioning correctly.
8. Adjust impellers. Check impellers for maximum efficiency setting and adjust if necessary.
9. Check for oil leaks. Air lift pumps may contaminate the well with oil from the compressor.
10. Protect all pumps and plumbing from freezing.

MAJOR PARTS AND COMPONENTS OF A CENTRIFUGAL PUMP

The major parts of a centrifugal pump are named in the following paragraph. They may be seen on the cutaway pump in the classroom, or in figure 1 in this study guide.

1. Pump body
2. Pump shaft
3. Impeller
4. Packing and lantern ring (if pump is equipped with one)
5. Packing gland
6. Suction and discharge nozzle

SUMMARY

Many pumps are required in both water and sewage plant operation. These pumps are classified according to design and use. Since pumps are subject to malfunction, it is necessary to be familiar with the commonly encountered types of pumps and to be able to perform maintenance on them.

QUESTIONS

1. What are the five major types of pumps?
2. What is the name of the rotor in a centrifugal pump?
3. How may the direction of rotation be determined on a centrifugal pump?
4. What type of pump is most frequently used in a water works system?
5. Explain the principle of operation of the air lift pump.
6. Name the parts of an ejector well pump.
7. What type of operation is suitable for ejector well pumps?
8. Where is the motor and the cylinder of a reciprocating well pump located?
9. In which type of well is a reciprocating well pump used?
10. What type of pump is a rotary pump?
11. What is the meaning of the word "cavitation"?

REFERENCES

1. AFM 85-13, Maintenance and Operation of Water Plants and Systems
2. TM 5-661, Water Supply Systems at Fixed Installations

WATER WELL MAINTENANCE

OBJECTIVE

This study guide is to acquaint you with the construction features of water wells and the maintenance required to maintain the maximum production from the well.

INTRODUCTION

Any large concentration of troops such as found on established bases must have an ample supply of water. In some cases one or more water wells must be drilled to furnish water because lakes and rivers may not be available as a water source.

Civilian contractors normally drill the wells; however, once the contractor completes the well, the military personnel have to maintain it, especially in overseas areas.

To familiarize you with water wells, we will cover the information under the following topics:

- Methods of Drilling Wells
- Construction Features of Wells
- Well Maintenance
- Capacity of Wells

METHODS OF DRILLING WELLS

In most areas of the world fresh water can be obtained by digging or drilling into the ground. Shallow holes of only a few feet in depth will produce water in some areas, while at other areas, perhaps not far away, it is necessary to drill through several hundred feet of earth and rock to obtain a supply of water. For the purpose of this lesson, the deep source of supply will be our interest. Shallow dug wells will not normally be used for military water supplies due to the difficulty in maintaining the structural and sanitary conditions of these wells.

Ground water may occur at places where it is least expected, such as deep under the Mojave Dersert, or very shallow under the Arabian Desert. Even more variable than the locations and depths at which water is found is its chemical, physical, and bacteriological characteristics. Even when these characteristics are such to render the water unfit for drinking or other uses, they can almost always be altered sufficiently to serve the purpose. However, there is one important aspect of ground water that cannot be changed. That is, the quantity which occurs at a particular place. Almost all ground water used for water supplies has its origin in rain and snow. The amount of this precipitation that becomes ground water depends on several factors. A portion of this precipitation is taken up by evaporation or is taken in by plants and trees. Another portion flows away in the form of surface run off. The remainder continues downward through the soil until it strikes a layer of rock of relatively impervious material. It then begins to move in the downhill direction of the impervious layer, taking the path of least resistance. The layer of sand, soil, gravel or broken rock through which the water moves is known as the aquifer, and the top level of the water in the aquifer is known as the water table. In order to reach this water table it is necessary to drill wells.

Percussion Drills

Holes or shafts sunk into the earth to obtain water are called wells. The kind of well and the method by which it is sunk depends on the type of ground and the depth of the aquifer. The earliest practical method of drilling wells was with a percussion drill. The process of drilling with a percussion (sometimes called a cable tool) drill is accomplished by alternately lifting and dropping a heavy bit and drill stem. The impact of the bit breaks up the rock and loosens the material in the hole. The loosened material, known as drill cuttings, is removed from the hole by a bailer. The bailer consists of a large tube or bucket with a hinged door or flap on the bottom end. When dropped into the hole the bailer fills with drill cuttings mixed with water and the flap or door prevents it from emptying until it is brought to the surface.

During the process of drilling, water is added to the hole to aid the drilling process. Also in almost all wells drilled by this method, the well is cased from top to bottom at the time of drilling to prevent caving and as protection against contamination from surface water. This casing is nothing more than a large steel pipe that is forced into the hole.

This method of well drilling is no longer in great use because of the time required to drill a deep well. Nevertheless, it is still considered to be a very efficient method.

Rotary Drills

The rotary drilling method has almost completely replaced the percussion method of well drilling due to its many advantages.

In the rotary method, the hole is drilled by the drill pipe with the bit attached. The bit cuts and breaks up the material as it penetrates the formation. Drilling fluid is pumped through the rotating drill pipe and flows from holes in the bit. This fluid swirls in the bottom of the hole picking up the material cut by the bit. It then flows upward in the space outside the drill pipe, carrying the cuttings to the ground surface, thus keeping the hole clean. The drilling mud or fluid is then sent to settling pit or basin to allow cuttings to settle out.

The rotary is much faster than a percussion type drill and has another advantage of sealing the side walls of the shaft as it drills by forcing the mud into the pore spaces of the shaft and prevent caving to a certain extent.

Rotary drilling and percussion drilling are not the only methods of drilling wells, but they are the ones widely used for either domestic or Air Force use. Therefore, the other methods such as hand digging, jetting, or driven wells will not be discussed at this time.

CONSTRUCTION FEATURES OF WELLS

The construction features of wells vary according to locality, terrian, desired yield, requirement, and depth of aquifer. Regardless of any other features that may be used for construction, all wells will have some basic features that will be the same. Some of the basic features are as follows:

1. Wells will be located on relatively high ground so rain water will flow away from and not toward the well.

2. The well head or discharge will always be above ground level to prevent contamination from spillage or leakage and other sources of contamination.

3. There will be a sanitary seal between the top of the casing and the pump.

4. Cesspools, privies, septic tanks and sewer lines will not be allowed within 100 feet of any well.

5. Vent pipes will be extended at least 18 inches above the pump apron and end in an elbow pointing downward with a screen covering.

6. All wells should be housed over and locked.

Straight Cased Wells

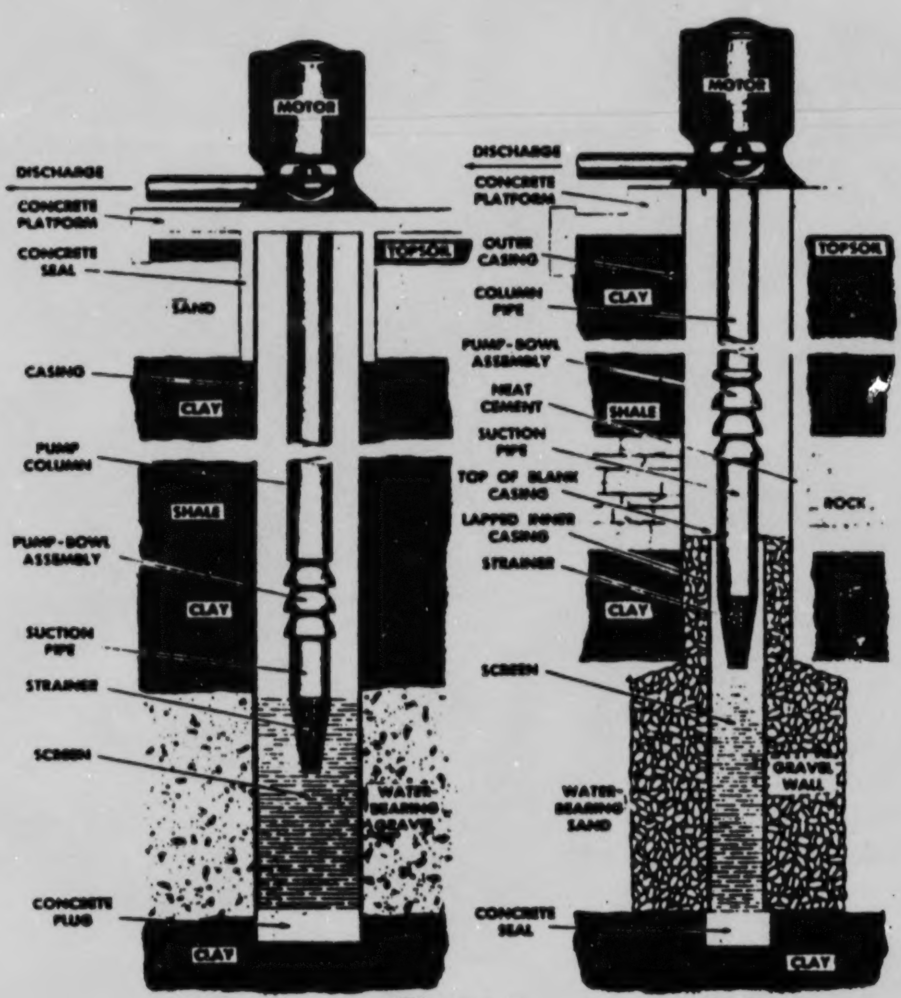
Straight casing of wells are probably the most common type used. Straight casing consist of a large pipe or housing for the pump, that is installed at the time of drilling. This casing or pipe should extend from a minimum of 4 inches above the surface into the last impervious layer of earth or rock overlying the aquifer. In addition to the casing, there is also a well screen to be installed upon completion of installation of casing. This screen prevents large gravel and shale from entering the pump while in operation. The length of the screen is determined by the thickness of the water bearing sand formation. Well screens must be resistant to the corrosive effects of the water; therefore, many different types of metal are used. The two most common metals used are brass or stainless steel.

Gravel Packed Wells

As a further aid in keeping out fine particles, gravel is frequently placed around the well screen. To place the gravel, it is necessary to construct a hole of larger diameter and use a double casing down the aquifer. A space in the aquifer is then made to receive the gravel. (For a comparison of the differences in construction features see figure No. 1).

Water from the aquifer fills the spaces between the gravel which acts as a reservior. This increases the open face area of the aquifer, thus, reducing the velocity of the water entering the well. The slow moving water does not erode the open face area of the aquifer and does not carry as many fine particles in suspension. As a result, the screen and the aquifer around it are not clogged and the amount of water delivered by the well does not decrease as much over a longer period of time.

A gravel packed well is more expensive to construct, but in most cases the cost is more than off-set by increased production.


DISCHARGE
CONCRETE PLATFORM
CONCRETE SEAL
SAND
CASING
PUMP COLUMN
PUMP-BOWL ASSEMBLY
SUCTION PIPE
STRAINER
SCREEN
CONCRETE PLUG
MOTOR
TOPSOIL
CLAY
SHALE
CLAY
WATER-BEARING GRAVEL
CLAY
DISCHARGE
CONCRETE PLATFORM
OUTER CASING
COLUMN PIPE
PUMP-BOWL ASSEMBLY
NEAT CEMENT
SUCTION PIPE
TOP OF BLANK CASING
LAPPED INNER CASING
STRAINER
SCREEN
WATER-BEARING SAND
CONCRETE SEAL
MOTOR
TOPSOIL
CLAY
SHALE
ROCK
CLAY
GRAVEL WALL
CLAY

(1) Figure 1 (2)

Comparison between (1) Straight Drilled Well and (2) Underreamed Gravel - packed well

WELL MAINTENANCE

After a well has been drilled and developed and permanent pumping equipment installed, it becomes an integral part of a planned and designed water system, whether it be municipal or military. The water, thus, produced can be well considered the lifeblood of the municipility or the military installation.

Too often the wells and pumps are separated and located apart from the water plant proper; and consequently, are not given the care and attention usually bestowed on the water plants themselves. The operator or maintenance personnel of a water supply system utilizing wells and pumps should fully acquaint themselves with the structural details of the well or wells, casing sizes, types of screens, screen elevations, and other pertinent data, particularly a record of the pumping test prior to acceptance of the well as a permanent part of the water supply system.

This record should include static water level, gallons per minute pumped, and pumping levels. A complete pump record indicating the type of pump installed, sizes and dimension of component parts, amount or length of pump column, air line lengths, and a performance curve of the pump bowl unit should be made available to the operator or maintenance personnel. This data can usually be obtained from the contractor at the time the well is put into service.

This data is very important. It provides a basis for comparison with daily pumping records. The importance of these records can be realized by remembering that the only way you can see what is happening in the bottom of the well is by the comparison of these records or logs. A marked discrepancy between the original test data and the current pumping record would indicate that something is wrong.

Usually, the first indication of well problems appears as a lowering of the water table, increased pumping levels, decrease in production, muddy, sandy or salty water or unusual noise or vibration in the pumping equipment.

These items can be quickly spotted when carefully maintained records of the static level and drawdown is correlated with capacity or pumping rate. This helps to anticipate difficulties in advance and provide data for proper maintenance measures. The following examples prove the value of properly maintained records:

1. A falling static level may indicate gradual lowering of the water table.

2. An increased drawdown may show receding ground water level, interference of other wells, leaky casing or delivery pipes, clogging, scaling or corroding of well screens, or gravel area becoming packed with sand or silt.

3. An increased drawdown when static level is unchanged is caused by increased resistance to water in flow and definitely indicates screen clogging, scaling, corroding, or sand and silt in gravel packed area around screen.

This indicates the importance of keeping accurate and proper records of performance. By being familiar with the possible causes of problems, it is much easier to determine how to correct them. An example of this is cleaning a clogged well screen by backwashing.

Backwashing

The surging effect, or reversal of flow required for backwashing a well screen and adjacent stratum, may be obtained by three backwashing methods.

One of these methods consists of alternately lifting water to the surface by pumping and letting the water run back into the well through the pump column pipe. To accomplish this effect, the pump is started; but as soon as water is lifted to the ground surface, the pump is shut off. The water then falls back into the well through the column pipe. The pump is started and stopped as rapidly as the power unit and starting equipment will permit. The effect is to intermittently lower and raise the water level in the well which produces the inflow and outflow respectively through the screen openings.

This operation should be performed as a regular preventive measure to eliminate the clogging of wells and well screens. Generally, a well that has been surged or backwashed using this method on a regular schedule will not have clogging problems for many years.

Another method of backwashing is by pouring or running a large amount of water into the well as rapidly as possible, thus, producing outflow through the screen opening. Inflow is then produced by bailing water out as rapidly as possible. As can be seen, this is not a very rapid means of surging as the time required for a complete cycle will be several minutes, plus the fact that the pump must be removed before this surging can be performed.

Of all the many methods known and tried the method of using the pump for surging and backwashing has proven to be the most efficient and economical. Even with a good program for surging, sometimes this is not enough to keep the well screen from clogging.

Cleaning Well Screens

Well failures are often caused by a scaled up screen. When screen cleaning is necessary, one of these follwing methods will be used.

1. INHIBITED MURIATIC ACID: Acid can be used to dissolve the crust formed on well screens. A contractor is called to do this job as special pumping equipment is required. After the screen is cleaned, the well must be pumped to waste until all acid residue has vanished.

2. DRY ICE: Cleaning screens by dry ice is simple and safe. It may or may not do a good job. To use this method, dry ice is broken into fragments and dopped into the well until several pounds have been used. The top of the well is sealed and a great pressure will develop in the well. This pressure will create surges which sometimes is violent enough to clean the scale from a screen.

3. SURGING AND BACKWASHING WITH EXTERNAL WATER SOURCE: A well can be surged or backwashed without pulling the pump out of the well and without expert help. If bypass pump connections or washwater lines have not been provided for this operation, remove the flap in the check valve in the discharge line to obtain full head of water with tank pressure. Open pump discharge line valve and allow full head of water to rush down through the pump column and pump into the well. If the screen is badly clogged or the well is badly sanded or silted, the well will quickly fill and water will flow from vent holes in the pump head.

   CAUTION: Before starting wash water, be sure pump and motor turns freely; otherwise down rush of the water rotates the pump in the wrong direction and may unscrew the pump shafting.

In most cases cleaning of wells and well screens by one of these methods will restore a well to the original production capacity or even in some cases even more.

Disinfection of Wells

Wells must be disinfected when initially dug and after repairs have been made to the well and submerged well pumps.

To disinfect a well, first pump the well to waste for several hours to eliminate as much pollution as possible. Then calculate the volume of water in the well to determine amount of chlorine disinfectant needed. The recommended dosage of chlorine for super chlorination of a well is 150 PPM. Strong solutions may damage pump parts or the well screen. Pour chlorine solution directly into the well casing after flushing operation is completed.

To mix the chlorine solution throughly with the well water, connect a hose to the pump discharge and direct flow back into well casing. Raise pump base to provide clearance for the hose. Pump until a strong chlorine odor is noted. Reset the pump base and allow 24 hours contact time. After the lapse of the contact time again pump well to waste until all chlorine is removed and obtain samples for bacteriological analysis to determine potability before putting well back in service.

Inspection for sanitary conditions for the prevention of contamination of a well would include the following:

1. Check surface drainage. Make sure the surface earth is graded so that all drainage flows away from the well and pump hose. No standing water should be allowed within 50 feet of the well.
2. Check area and allow no livestock within 50 feet of the well. If necessary, fence the well site.
3. Make sure the concrete slab or apron around the well is water-tight and that no water can work under the apron and into the well.
4. Check the top of the well casing to be sure that the sanitary seal is intact and water tight.
5. Check vent screens to make sure they are not torn or clogged. The vent should end in an elbow or equivalent which points down and is at least 12 inches above the top of the well casing and 18 inches above the pump apron or pump house floor. Be sure that all water used for bearing lubrication and pump priming is from a safe approved source.

6. Be sure that well heads, well casings, pumps, pumping machinery, exposed suction pipes or valve boxes connected with an exposed suction pipe are not located in any room or space lower than ground level.

7. The water sample tap must be installed in the discharge line near the pump, facing downward.

8. Make sure water for cooling parts of engines, air compressors, pumps, or other equipment is not returned to any part of the water system.

9. Make sure there are not any cesspools, privies, septic tanks, or sewer lines located less than 100 feet of a well.

Protection from Freezing

All wells must be protected from freezing in cold or arctic climate. Methods used to prevent freezing of wells or pumping equipment will vary depending on the severness of the climate.

One method of preventing freezing is to have continuous operation. It is a known fact that moving water will not freeze as readily as still water.

When it is not possible to have continuous operation, it is better to drain all pumps and pipes. This is a time consuming operation, and unless the equipment is going to be out of operation for several days, it isn't the most practical, but may be the only way possible to prevent freezing.

For all sound operation and protection the most practical method is to construct heated well houses. These should be large enough to cover the pump head and motor or in some cases may be large enough to include discharge piping and other equipment. In some artic climates it is necessary to have heated pipe lines from the well into the storage area. This is usually accomplished by means of heated tunnels from one building to the other.

CAPACITY OF WELLS

The capacity of a well depends on the relationship between static water level, active static water level, and pumping level. See figure 2.

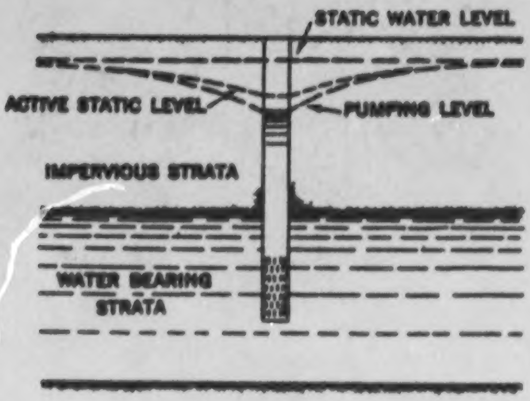


Figure 2

WATER LEVEL RELATIONSHIPS

Water levels and drawdown measurements are necessary for an accurate determination of the capacity of a well and for operation within safe limits. For a better understanding of static level, pumping, and other associated terms see the definitions listed below:

1. Static Water Level - The level of ground water in a well before pumping.

2. Pumping Level - The elevation at which water stands in a well when the well is being pumped at a given rate.

3. Drawdown - The difference between static level and pumping level.

4. Maximum Yield - This is the maximum number of gallons per minute that can be pumped from the well over a six-hour period during which the pumping rate is maintained so the pumping level remains stationary, but any increase in pumping rate would cause the well to run dry.

5. Desired Yield - This is the rate at which the well is expected to produce.

6. Safe Yield - This is the rate of pumping that produces a drawdown of 50 percent of the drawdown obtained when the well was built and pumped at maximum yield. Operating a well within its safe yield will prolong its productive life.

7. Specific Capacity - This is the number of gallons per minute pumped per foot of drawdown. The specific capacity is not the same for each foot of drawdown, but is approximately so when the drawdown is not too great. Knowing the specific capacity of a well enables the operato to estimate the drawdowns that will be produced at different pump settings.

Comparison of these measurements over a period of time reveals changes in well characteristics and indicates when maintenance is necessary.

Since the water level falls gradually when pumping is begun, the pumping level is normally determined after an hour of continuous operation. Since wells are normally operated intermittently, measure drawdown whenever possible, for the static level to which the well returns after full recovery. Determine the normal recovery time and make periodic checks for any change in recovery. Such changes may indicate serious trouble.

When water is pumped from a well, a depression is produced in the water table (see figure 3). This depression is called the "Zone of

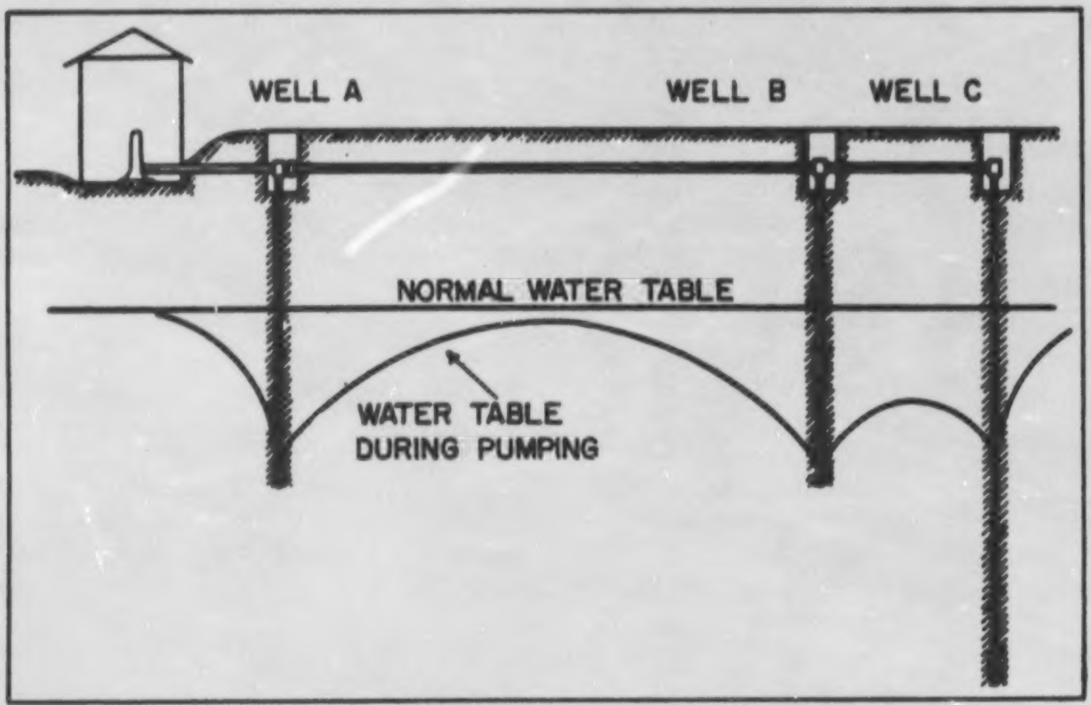


Figure 3. Zone of influence of well pumping on water table.

influence" of the well. Zones of influence of wells close together may overlap so that, if the wells are pumped simultaneously, they will compete with each other for the water (see figure 3). As a result each well produces less water than if it were operating by itself. Thus, when a water supply is taken from a group of wells, the wells being pumped at any one time should be far enough apart so that the zones of influence do not overlap.

Measure Water Levels and Drawdown

To check the water level, lower a 1/4-inch pipe (telltale) of known length into the well to a depth known to be below the drawdown level. Connect the surface end of the line to a bicycle pump and connect a pressure gauge into the line so the air pressure in the line can be read. Make all joints airtight. With the well pump shut down, apply air pressure through the bicycle pump until the gauge needle no longer registers any increase in pressure. The reading of the gauge then shows the amount of pressure that was necessary to force the standing water out of the telltale. This is directly proportional to the height of water standing in the well above the bottom of the telltale. Multiply the pressure in p.s.i. by 2.31 to determine the height in feet. To determine the distance below the air guage at which the water stands in the well, subtract the calculated height of water above the bottom of the telltale from the known length of the telltale below the well top. This is the static level.

Start the well pump and observe the air gauge until the reading no longer changes, pumping in additional air to make up for any leakage. Convert this pressure reading to feet. It is the height at which water stands in the well above the bottom of the telltale during pumping. Deduct this from the length of the air pipe below the well top to get the pumping level. The difference between the static level and the pumping level is the drawdown.(see figure 4).

EXAMPLE:

Assume length of (L) of airline (tell-tale) is 150 feet. Assume that the pressure gauge reading (P_1) before starting the pump is 25 p.s.i. Then the pressure converted to feet (A) is 25 x 2.31 = 57.7 feet. The static water level (B) = L - A = 150 - 57.7 = 92.3 feet. Assume that the gauge reading (P_2) during pumping is 18 p.s.i. Converted to feet (C) this is 18 x 2.31 = 41.6 feet. Then the pumping level (D) = L - C = 150 - 41.6 = 108.4 feet.

The drawdown is determined by any of the following methods:

1. D - B = 108.4 - 92.3 = 16.1 feet
2. A - C = 57.7 - 41.6 = 16.1 feet
3. $P_1 - P_2$ = 25 - 18 = 7 p.s.i.; 7 x 2.31 = 16.1 feet

Record water level and drawdown correlated with capacity or pumping rate on AF Form 996, 1354, and 1461. This helps to anticipate difficulties in advance and provides data for proper maintenance measures, as well as making a permanent record for future reference.

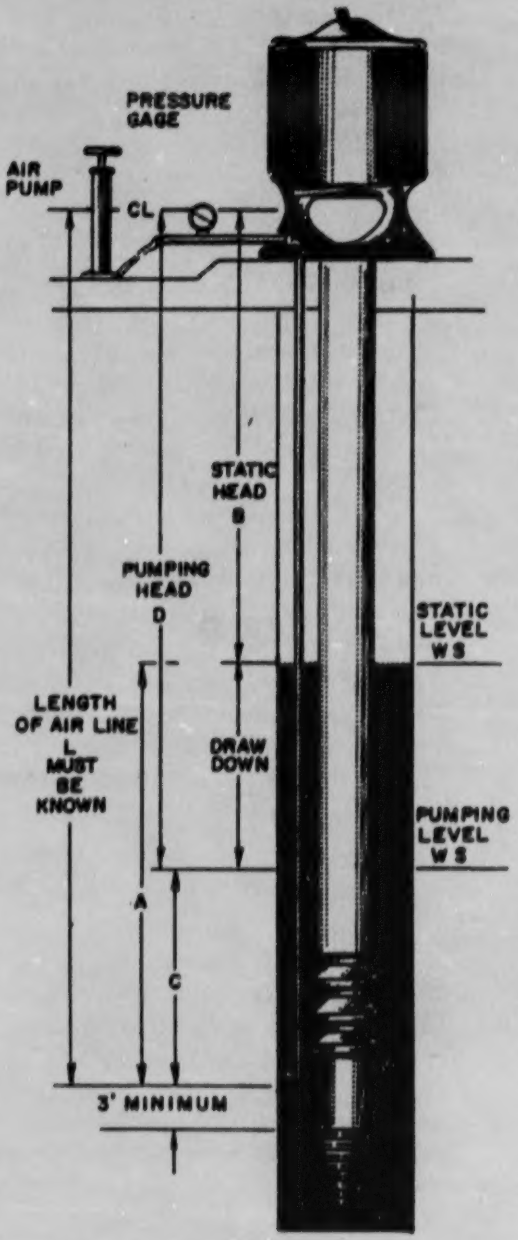

PRESSURE GAGE
AIR PUMP
CL
STATIC HEAD B
PUMPING HEAD D
STATIC LEVEL W S
LENGTH OF AIR LINE L MUST BE KNOWN
DRAW DOWN
PUMPING LEVEL W S
A
C
3' MINIMUM

Figure 4. Using air line to find depth of water level.

SUMMARY

Wells are relatively simple structures. Proper maintenance is necessary to insure a continuous and adequate supply of safe water. The failure or contamination of a water supply can have serious consequence for a base mission. Failure of wells may require water rationing or may result in temporary lack of water for even such necessities as drinking and cooking. Should a fire occur during a period when water is unavailable, the results could be disasterous. Contamination of a well can result in the rapid transmission of water borne diseases to a large number of people. To prevent any of these incidents, wells must be maintained in a satisfactory structural, mechanical, and sanitary condition at all times.

QUESTIONS

1. What is the purpose of the well casing?
2. What is the minimum distance for cesspools, privies, etc., around a well?
3. What is the purpose of the telltale when computing the water level of a well?
4. The casing should be how deep in a well?
5. Define static water level.
6. When the factors are equal, such as amount, accessibility, between ground water and surface water, which would usually be selected for use of a military water supply?
7. Define pumping level of a well.
8. When you know the static and pumping levels of a well, how can you determine the drawdown?
9. What is the indication of an increased drawdown when the static level is unchanged?
10. What method should never be used for cleaning well screens?
11. How much chlorine should be used for super chlorination of newly drilled water well?
12. What is the best method of preventing wells from freezing in extreme cold weather?

13. Define safe yield of a well.

14. Name three different types of drilled wells.

15. What chemical is used for cleaning stainless steel well screens.

REFERENCES

1. AFM 85-13, Maintenance and Operation of Water Plants and Systems

2. AFM 85-23, Well Drilling Operations

MODIFICATIONS

Pages 101- 119 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

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WORKBOOKS 3ABR56330-VI-1-P1 Thru 8-P1

Department of Civil Engineering Training

Engineer Environmental Support Specialist

MAINTENANCE OF WATER AND WASTE PROCESSING COMPONENTS

March 1972

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

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MAINTENANCE OF WATER AND WASTE PROCESSING COMPONENTS

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Dept of Civil Engineering Tng
Sheppard AFB, Texas

WB 3ABR56330-VI-1-P1
6 March 1972

INTRODUCTION TO EXTERNAL CORROSION CONTROL

OBJECTIVE

The purpose of this exercise is to assist you in inspecting for corrosion and to determine preventive measures.

1. Define the corrosion of metal.

2. Name the three types of corrosion that appear on iron.

   a.

   b.

   c.

3. What are the four requirements needed for galvanic corrosion to occur?

   a.

   b.

   c.

   d.

4. The instructor will show you several samples of corrosion. In the spaces below, you are to list the types of corrosion found on the samples.

   a.

   b.

   c.

   d.

   e.

5. How could you have prevented the corrosion from occurring on the metal you listed above?

   a.

   b.

   c.

   d.

   e.

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CATHODIC PROTECTION

OBJECTIVE

The purposes of this exercise is to aid you in understanding techniques used in cathodically protected systems.

1. What are the two systems used in cathodic protection?

   a. ____________________

   b. ____________________

2. Why will the large buried anode corrode instead of the protected structure?

   ____

   ____

3. Identify three items that can be protected by cathodic protection.

   a. ____________________

   b. ____________________

   c. ____________________

4. Using a multimeter, measure the voltage of a flashlight battery and record it.

   ____

   CAUTION: Do not attempt to measure the AC voltage of a wall plug or lab table outlet.

5. Using the multimeter, measure the voltage on a cathodically protected pipeline.

   Voltage read ____________ volts.

DRIVE EQUIPMENT AND ACCESSORIES

OBJECTIVE

The purpose of this exercise is to aid you in the inspection and maintenance of equipment common to water and waste installations.

1. Name four conditions that you would observe during a daily inspection of a chain driven piece of equipment.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

2. What is the reason for performing daily inspections? ______________________________

   ____

Electric Motors

3. Inspect an operating electric motor.

   a. Is there any unusual noise in the motor? Yes - No

   b. Does the shaft wobble or shake? Yes - No

   c. Is the motor securely mounted? Yes - No

   d. Is the motor housing overheated? Yes - No

   e. Are there any sparks coming out of the motor? Yes - No

4. Inspect after operation.

   a. Is the motor dirty with mud, grease, rag lint, or leaves and grass? Yes - No

   b. Does the motor have an oiling hole or grease zert? Yes - No

   c. Are the electrical wires in good condition? Yes - No

   d. Is there any exposed naked wire? Yes - No

Drive Equipment and Accessories

5. Inspect a belt-driven piece of equipment.

   a. Is the belt a flat belt or V-type? ______________________________

   b. What is used to obtain the proper tension on the belt? ______________

   c. What would happen if this belt were to loosen? ____________________

   ____

   d. What does a belt look like when it is worn out? ____________________

   ____

6. Inspect a chain-driven piece of equipment.

   a. What method is used to tighten this chain? _______________________

   b. Is each link free to swivel or is it stiff due to corrosion? ____________

   c. Is this chain a low, medium, or high speed chain? _________________

   d. Are there any means for lubricating this chain? ____________________

7. Remove the belt drive safety cover on the hypochlorinator.

   a. How can the speed of this equipment be varied? ____________________

   ____

   b. Should there be three belts or only one? _________________________

   c. What provision is made to keep the belt at the proper tension? ________

   ____

8. Inspect the coupling between the motor and the Peerless Fluidyne pump.

   a. What absorbs the shock of starting and pumping variations? __________

   ____

   b. What wrench is needed to loosen this coupling from the shaft? ________

   ____

9. Inspect the speed reducing gear on the L head 90° chemical feeder.

   a. What is the ratio of the reduction gear? 1 to ______________________________

   b. What tool is needed to loosen the coupling on the motor shaft? ______________

   ____

   c. What type of wrench is needed to loosen the coupling between the reducing gear and pump? ____

   d. What absorbs operating shocks in these two couplings? ______________

   ____

OPERATING A GASOLINE ENGINE

OBJECTIVE

The purpose of this exercise is to aid you in learning the correct procedures for inspecting and operating small gasoline engines.

Preoperation Procedures

1. Fill fuel tank. WARNING! Do not attempt to refill the fuel tank while engine is operating.
2. Remove fuel tank filler cap and check cap vents to make sure they are not clogged. This may be done by blowing through the vents.
3. If the engine is used with a generator to produce power, make sure the frame is grounded.
4. Always use funnel to fill fuel tank. If any fuel is spilled, wipe clean and allow time for the fumes to evaporate before starting engine. Check complete fuel system for leaks.
5. Check oil. Oil should be seen in the oil filler pipe. (If low, add 20 wt oil as required.)
6. Make sure that the water pump inlet and outlet are properly connected to water supply and reservoir.
7. Prime the water pump by removing the square plug in top of pump housing and fill with water.
8. Visually check overall condition: fuel or oil leaks, loose nuts or fittings.

Starting Procedure

1. Check to make sure fuel shutoff valve is open. Valve is located under fuel tank.
2. Pull carburetor choke valve all the way out.
3. Position grounding switch in run position. (Move it away from spark plug.)
4. The engine you will operate here in school has an automatic governor so no throttle control is necessary.
5. Take hold of the recoil starter rope and use a quick steady pull to spin and start engine.
6. After engine starts, allow engine to warm up, then push choke in.

Operating Procedure

The automatic governor will take over control of the engine speed and adjust engine speed to pumping conditions.

Stopping Procedures

1. Move spark plug grounding switch against the plug.
2. When engine will not be restarted for a long period time, the carburetor should be drained. This may be done with drain valve in carburetor.

MAINTENANCE OF PIPELINES, VALVES, METERS AND RECORDERS

OBJECTIVE

The purpose of these exercises is to aid you in the maintenance of water and waste components.

Pipelines

1. Identify three methods used in locating a buried pipeline.

   a. ____

   b. ____

   c. ____

2. Explain the principle used by the electric meter in locating water leaks.

   ____

   ____

3. Obtain a saddle clamp and place it on the trainer pipeline. Cover a hole and secure it so that there is no leakage when tested by waterline pressure.
   NOTE: Do not use a pipe wrench during this project.

4. Name two other field methods used to repair a water leak.

   a. ______________________________

   b. ______________________________

Valves

1. Disassemble and reassemble a valve

   a. Place a 1 1/4-inch gate valve, stem up, in a vise, and tighten the vise just enough to hold the valve securely. Too much pressure will warp the valve or crack it.

   b. Remove the round handle, and place the nut and handle on the workbench.

   c. Loosen and remove the top packing nut. The packing compression ring can now be seen.

   d. Carefully raise the brass compression ring with a rag in the jaws of pliers.

e. The lead ring packing can now be seen. If the top packing nut you removed was screwed down all the way, then additional lead washers can be placed in position. If no washers are needed, gently tap the compression ring down until it seats, using a plastic mallet or a piece of wood.

f. Place the packing nut on the stem and tighten it snugly. Too much force will only cause the valve stem to bind and make it hard to turn.

g. Put handle on stem and snug the nut gently.

2. Place the valve back in the bin.

Meters

1. Disassemble and reassemble a watermeter.

a. Set the Hersey meter on the workbench.

b. Remove the large flange bolts.

c. Lift the top body off and lay it on its side.

d. You can now see the wobble plate and the small drive pin in the center of the plate in the bottom section of the meter.

e. Notice the filter screen at the inlet port.

f. Now look at the bottom of the top section. Notice the spinner. With your finger turn the spinner and watch the dial of the meter. What happens?

g. Can you now determine how the meter registers the amount of water flowing through the meter? If not, ask your instructor to explain it.

h. Carefully replace the top section on the bottom section, and install the flange nuts and bolts. Tighten the nuts only finger tight as the meter will be taken apart again very shortly.

2. Read and record the water used as shown on the dial.

a. The round dial will record 10 gallons after one complete revolution.

b. When 10 gallons have been used, the first movable number to the right above will increase by one. Example: 4 will turn to 5.

c. How many gallons is this meter capable of measuring? ____________________

d. Record the reading on the meter and have your instructor check your reading

____________________.

Recorders

1. Change the chart on a recorder
   - a. Open the door and observe the components that hold the chart in place.
   - b. In the upper left corner, gently raise the lever to raise the inking pin from the chart.
   - c. Pull out gently on the knob located in the center of the chart.
   - d. Now carefully remove the chart.
   - e. Replace the chart in reversed procedure.
   - f. Turn the chart paper so as the inking pin will start its travel on the day and hour that you perform this project.
2. Apply ink to the pen.
3. Do not attempt any type of repair on a recorder as this is done by the precision measurement equipment laboratory on each base.

CHEMICAL FEEDER MAINTENANCE

OBJECTIVE

The purpose of this exercise is to aid you in the maintenance procedures of chemical feeders.

Chemical Feeders

1. How may leaks be detected in chlorine lines? ____________________
2. What procedure can be used to prevent chlorine valves from sticking or becoming set? ____________________
3. What material is the gasket made of that is used in connecting chlorine cylinders? ____________________
4. Why should a brass valve not be used in ammonia systems? ____________________
5. When using a pump type solution feeder, how can you determine if solution is being fed? ____________________

PROCEDURE

Disassembly and Reassembly of a Hypochlorinator

1. Using a small screwdriver or sharp edge tool, remove the round inspection plate on top of the unit .
2. Inspect the worm gear for loose play by wiggling the shaft pulley.
3. Check the top screw with a screwdriver for tightness.
4. Check oil level, it should be above the bearing.
5. Inspect camshaft spring for breakage.
6. Replace inspection plate.

7. Remove the eight screws holding the plastic head over the diaphragm and lift off the head.

8. Turn counterclockwise to unscrew the diaphragm. Inspect the diaphragm for holes or tears.

9. Check the swedges for ease of movement by turning the stroke control knob.

10. Replace the diaphragm and turn until it seats then back up until the first diaphragm notch lines up with the screw holes.

11. Replace the plastic head and very gently snug the screws as overtightening can break the plastic.

12. Now unscrew the top and bottom poppet valve covers and check the condition of the poppet valves. They should not be nicked, torn or cut. They should seat easily and be easily removable.

13. Replace the poppets and poppet covers.

14. Check the motor for security of mounting and the belts for proper tension.

IDENTIFICATION OF PUMPS AND PARTS

OBJECTIVE

The purpose of this exercise is to aid you in the identification of various types of pumps and pump parts. These different types of pumps and equipment are used for many different purposes in water and waste treatment plants.

IDENTIFYING A CENTRIFUGAL PUMP

1. What type of pump is most commonly used to pump water and sewage in a sewage plant and has a rotating impeller enclosed in a spiral volute, or casing?

2. List principles of operation for reciprocating sludge pumps.

3. List the different types of reciprocating pumps.

4. Explain the principle of operation for a turbine well pump.

5. List the equipment necessary and the normal uses of a sewage ejector.

6. What type of packing seal is used on water and waste type centrifugal pumps?

7. How can the pumping capacity of a reciprocating pump be regulated?

8. What is the purpose of ball check valves in reciprocating pumps?

9. What other name is used for axial flow pump?

10. For completion of the following exercise match the Figure number from the following pages to the description of various pumps listed below and state the type of pump.

    a. Moves sewage from a lower level to a higher level by means of compressed air. Complete unit includes air compressor and controls in one sealed unit.

    b. Two stage, with bottom suction, horizontally split case, oil or grease lubricated bearings, renewable type packing.

c. Fully enclosed impellers, shaft couplings, aligning spiders, suction nozzle, and diffuser vanes.

d. Bottom suction, dual volute, arranged for synchronous motor drive on one end and standby engine operation on other end.

e. Multiply stage, high capacity, high head, usually used for transfer pumps.

f. Mechanically operated ball check principle, reciprocating action.

May be hand operated. Requires no surge chambers. Usually used for pumping sludge or heavy liquids.

g. Has one moving part installed in a spiral casing. Low head, high capacity, used for extremely large quantities of liquid.

h. Reciprocating, single plunger, ball check principle. Requires surge chambers, commonly used in sewage plants for sludge transfer.

i. Has cutting mechanism and conveyor type impeller and is used for pumping bulky type substances.

____

____

j. Incomplete system, consisting of dual chambers discharging into the same line. Low capacity ideally tested for basements. These units prevent odors and flooding.

____

____

k. Double suction, mechanical seal, side suction and discharge. High capacity and low head. Designed for transfer service.

____

____

l. Triple action, requiring surge chamber and gear drive. Commonly used for sludge or heavy liquids.

____

____

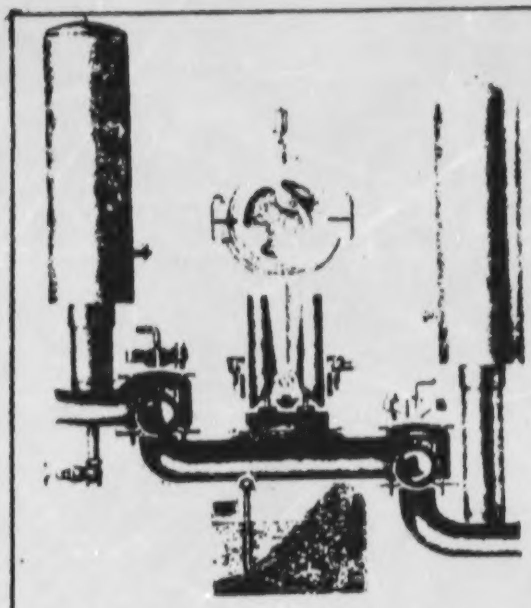


FIG. 1

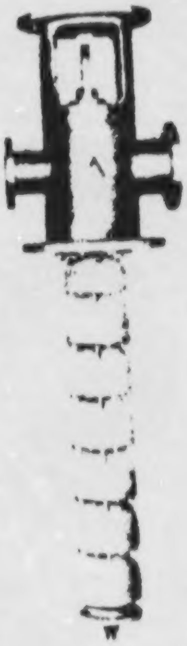


FIG. 2

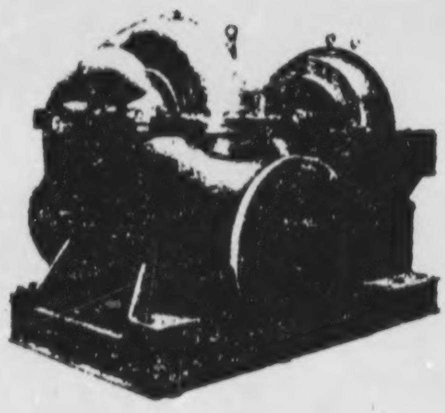


FIG. 3

FIG. 4

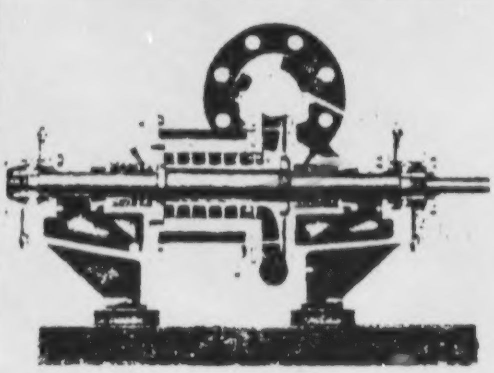


FIG. 5

FIG. 6

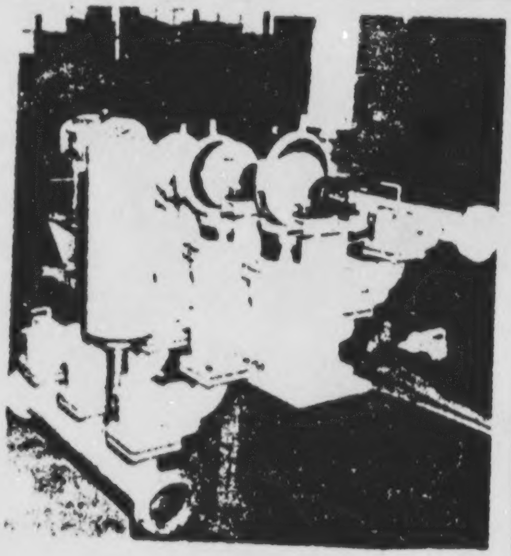


FIG. 7

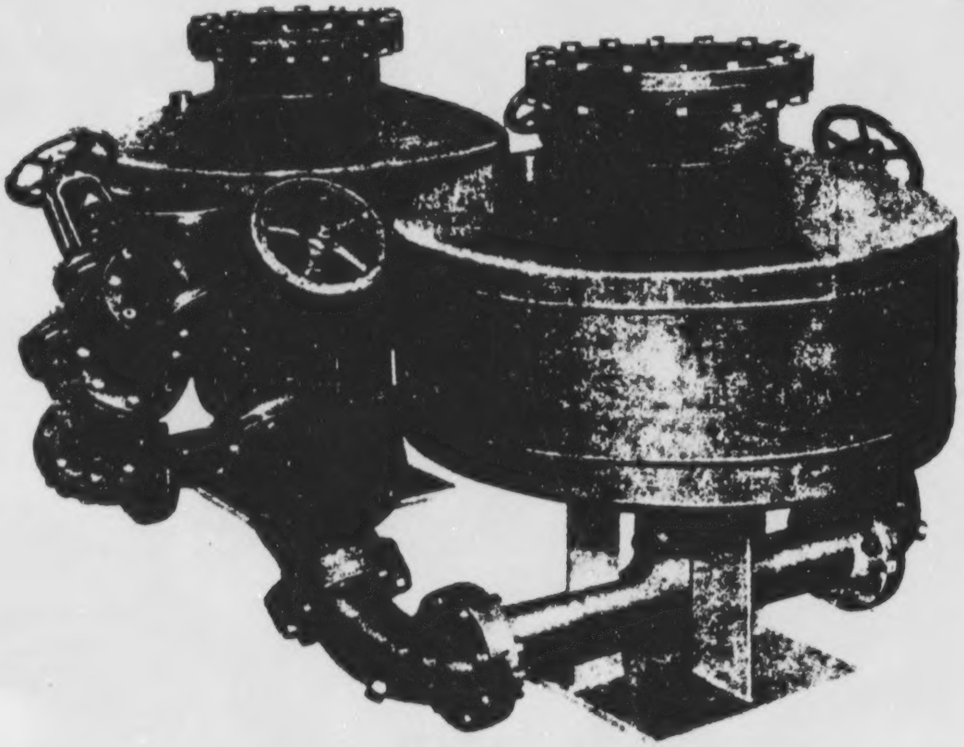


FIG. 8

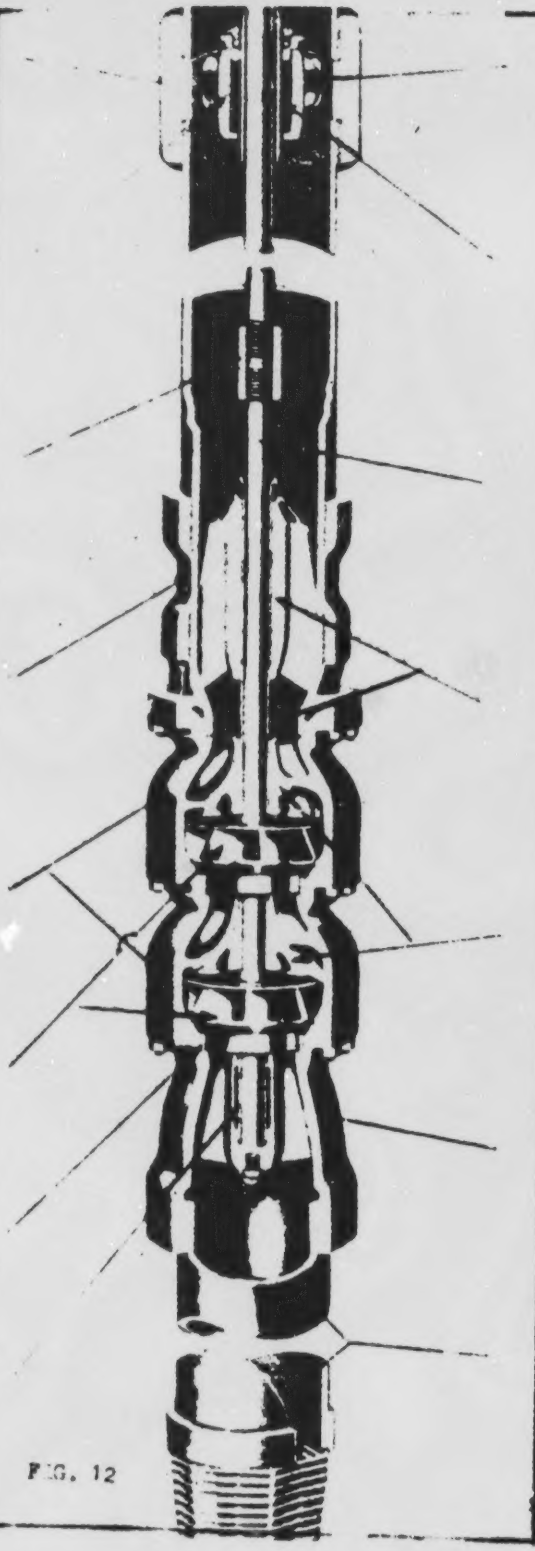


FIG. 12

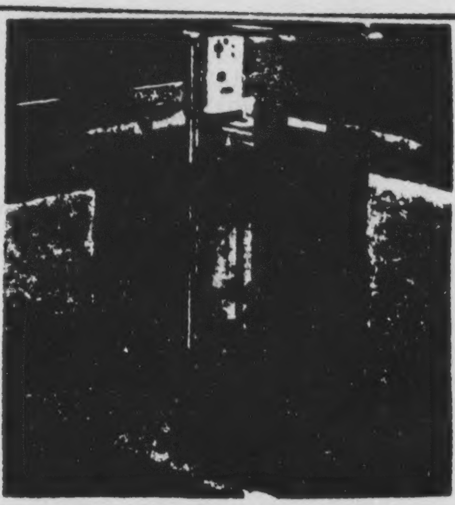


FIG 9

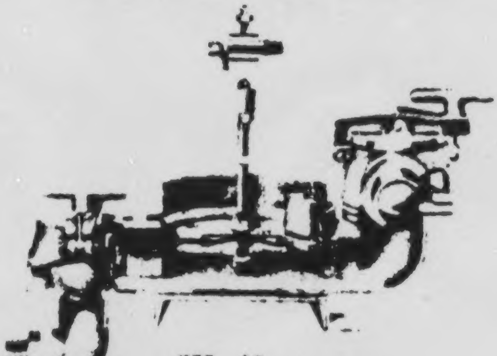


FIG. 10

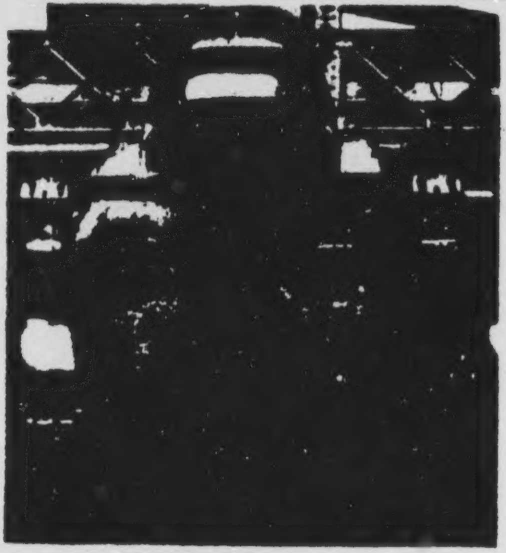
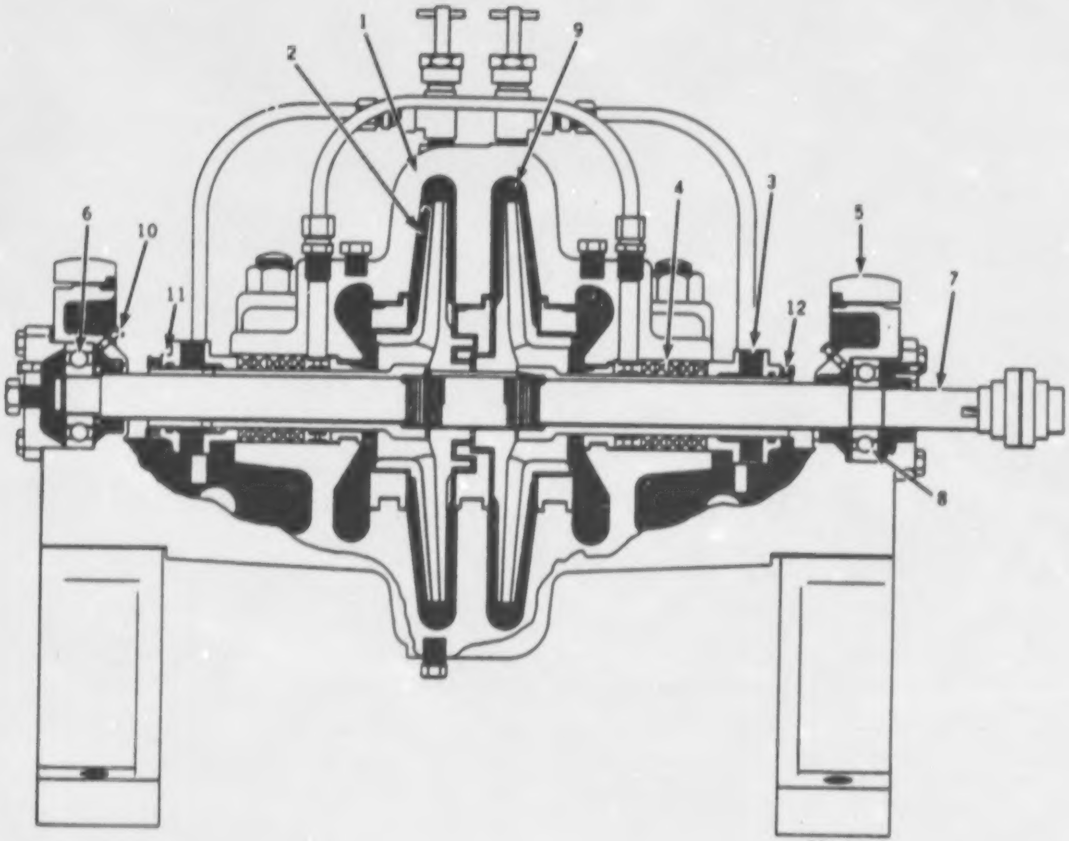


FIG. 11

IDENTIFICATION OF CENTRIFUGAL PUMP PARTS

The parts of the centrifugal pump in figure 13 below are numbered. Write the name of each part on the blank line next to the corresponding number of the part in the figure.



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________

TEARDOWN, REASSEMBLY AND OPERATION OF A CENTRIFUGAL PUMP

OBJECTIVES: The purpose of this project is to teach you how to disassemble a centrifugal pump, remove and replace the packing, reassemble the pump and then connect the pump into a water source and operate it, observing pump for proper operation.

PUMP DISASSEMBLY

1. The instructor will assign you a centrifugal pump.

2. Place the pump on the work bench.

NOTE: Do not use hammers or improper wrenches on this pump.

Removing the Impeller

1. Remove the cap screws holding the casing to the pump frame and remove the casing.

2. Remove the impeller lock-nut and washer.

3. Slide off the impeller and key.

NOTE: If it is necessary to pry off the impeller, be careful to pry evenly on opposite sides where denting or bending of the impeller shroud will not occur. Tightly stuck impellers will require the use of a wheel or gear puller.

Shaft and Bearing Disassembly

1. Remove the bearing retaining snap rings from both ends of the bearing frame. The snap rings can be pried out, but their removal can be done easier with a snap ring extractor.

2. Pull out the pump shaft with bearings attached from the coupling end of the pump frame.

NOTE: The bearings may be cleaned and inspected for serviceability without removal from the shaft.

Stuffing Box Disassembly

1. Loosen the hex nuts.

2. Remove the gland bolts and gland.

3. Pull out the packing rings and seal cage using a packing tool or a rod with a hook on one end.

PUMP REASSEMBLY

Make sure all parts are thoroughly clean before reassembling. Take care to keep the ball bearings absolutely clean. Do not over torque nuts and bolts as you may damage the equipment or strip the bolt threads.

Shaft and Bearings Reassembly

1. Replace the inboard bearing cover on the impeller end of the shaft and bring into place against the inboard bearing.

2. Slip the deflector on the shaft next to the bearing cover, then place the seal cage against the deflector.

3. Push the shaft assembly through the pump frame and slip on the inboard retaining ring before the shaft enters the stuffing box.

4. Set the inboard retaining ring into position.

5. Replace the outboard bearing cover and set the outboard ring into position.

Stuffing Box Reassembly

1. Cut two rings of packing (or whatever number is necessary to fill the space below the tapped hole in the stuffing box) so that the packing has a small amount of clearance when it is wrapped around the shaft.

2. Use the gland to push the packing into the stuffing box, staggering the breaks in adjacent packing rings 90 to 180 degrees apart.

3. Slide the seal cage into the stuffing box where it will locate in a position opposite the tapped hole.

4. Continue to fill the stuffing box with packing rings, having the breaks staggered 90 to 180 degrees apart, until there is only enough space for the gland to be started in the bore of the stuffing box.

5. Put the gland, gland clamps, and gland bolts in place and tighten the hex nuts enough to compress the packing slightly then loosen the hex nuts until the gland clears the top packing ring by one-eighth inch.

6. Further adjustment will be made after the pump has been started.

Impeller and Volute Casing Reassembly

1. Slip the impeller and key onto the shaft.

NOTE: If a shaft sleeve is used, the key must enter into the slot in the end of the shaft sleeve.

2. Replace the washer and lock-nut.

3. Replace the gasket using a nonhardening sealing compound such as grease or graphite.

4. Put the casing in place and fasten securely with cap screws.

NOTE: The pump should be thoroughly flushed to remove any foreign material which may have accumulated during the repair and inspection.

PUMP INSTALLATION

1. Reinstall the pump on the base plate.

2. Align the pump shaft with the motor shaft.

3. Manipulate the pump on the base plate until a check indicates that the distance between the faces of coupling is exactly the same at any point and a straight edge will be exactly level at all points.

4. Connect the suction pipe to the pump.

NOTE: When the pump is located above the liquid level, a foot valve on the end of the suction pipe will retain enough water in the impeller when the pump is shut down to prime it when starting. A gate valve should be installed in the suction line when the liquid is located above the pump.

5. Connect the discharge pipe.

NOTE: A check valve and gate valve should be installed in the discharge line.

6. Prime the pump, if the liquid level is lower than the pump, by removing the priming plug and fill the suction line and pump.

7. Replace the priming plug prior to starting the pump.

PUMP OPERATION

1. Turn the pump over by hand to make sure that it is free and not binding.

2. Check the rotation (rotation shown by the arrow cast on the casing) with a quick start and stop of the pump.

3. Prime the pump if it has not already been done.

4. Make certain that the gate valve in the suction line is fully open and that the gate valve in the discharge line is fully closed.

5. Start the motor and when it is up to full speed, slowly open the discharge gate valve.

Packing Gland Adjustment

1. Proceed slowly when tightening the packing gland. Never tighten the gland more than necessary. Never force the packing into a leak proof position.

2. Tighten the bolts evenly about one-sixth turn at a time, allowing an interval for the packing to creep into a better sealing position.

3. After you have adjusted the packing gland, the instructor will inspect your work.

TROUBLE SHOOTING GUIDE

PROBABLE CAUSE	REMEDY
FAILURE TO DELIVER WATER, OR SUFFICIENT WATER AND SUFFICIENT PRESSURE	
Pump not primed.	Reprime.
Pump not up to speed.	Check for incorrect motor voltage and motor overload.
Discharge head beyond pump shut-off.	Alter installation or provide pump suitable for higher pressure.
Excessive suction lift.	Reduce lift: use larger suction pipe.
Incorrect direction of rotation.	Reverse rotation.
Insufficient positive head on suction for hot liquids.	Give pump more submergence, simplify and increase size of suction piping.
Footvalve too small.	Replace with adequate size footvalve.
Strainer clogged.	Clean out.
Worn wearing ring or damaged impeller	Recondition or replace worn parts.
High spot or air pocket in suction line.	Repipe to pump suction to eliminate loose and high spots.
PUMP LOSES PRIME AFTER STARTING	
Excessive suction lift.	Reduce lift: use larger suction pipe.
Air leaks in suction line.	Check joints, make up tight with pipe joint compound.
MOTOR OVERHEATS	
Total head is higher than rated.	Larger motor is required. Check with dealer to see if head is in the operating range of the pump.
Liquid handled is of higher viscosity or specific gravity than that for which the pump was designed.	Check with dealer; a larger motor is required.
Mechanical trouble in pump or motor.	Check impeller fit, shaft straightness and ball bearings. See if motor turns freely.
Low voltage or incorrect voltage.	See that power supply is as required, check electrical connections to motor, check to see that wiring to motor is large enough.
PUMP VIBRATES OR IS NOISY	
Impeller partially clogged.	Disassemble pump and clean out impeller.
Insecure foundation.	Rebuild to give rigidity to pump and motor.
Bent shaft, impeller, or worn ball bearings.	Dismantle and replace worn parts.
Misalignment between motor and pump	Check alignment

WATER WELL MAINTENANCE

OBJECTIVE

This exercise is designed to aid you in understanding the importance of well maintenance requirements.

PROCEDURE

Enter the correct answer for the following questions in the space provided.

1. Why is proper maintenance of wells important from the consumer's standpoint?

2. What is a well?

3. What 3 things should be taken into consideration when determining the type of well to be used?

4. Why should wells be located on relatively high ground?

5. Why is a well that is dug usually of large diameter?

6. What type of well **excavation is made with a pointed screen?**

7. What is a free-flowing well called? ____________

8. What is meant by the term "Desired Yield?"

9. What is meant by the term "Safe Yield?"

10. How many pounds of pressure are needed to displace one (1) foot of water in a 1/4" pipe?

11. What is used to clean brass or bronze well screens?

12. How is surging a well accomplished?

13. What is meant by the term "Well Apron?"

____

____

14. What is the minimum distance livestock must be kept from a well?

____

Find the static level, drawdown and pumping level of a well when given the following data:

	Length of telltale	PSI before pumping	PSI after
15.	400	19	17
	____________ /	____________ /	____________
16.	500	22	20
	____________ /	____________ /	____________
17.	650	28	21
	____________ /	____________ /	____________
18.	970	47	43
	____________ /	____________ /	____________
19.	1115	63	52
	____________ /	____________ /	____________

ATC—SHEPPARD AFB TEX. 75-49

Block VII 17-7 246

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Introduction to Solid Waste Processing (Day 56)

LESSON DURATION

CLASSROOM/LABORATORY 2 Hrs	COMPLEMENTARY 0	TOTAL 2 Hrs

POI REFERENCE

PAGE NUMBER 49	PAGE DATE 6 Jun 75	PARAGRAPH 1

STS/CTS REFERENCE

NUMBER 563X0	DATE 28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-1 WB VII-1-P1 AFM 91-11

CRITERION OBJECTIVES AND TEACHING STEPS

1a. Given a list of various types of solid waste and three waste classifications (garbage, debris, and rubbish), list each solid waste type under its correct classification.

(1) Purpose of solid waste processing

(2) Personnel responsible for solid waste processing

(3) Classes of solid waste

(4) Edible and nonedible garbage

(5) Incinerable and nonincinerable debris and rubbish

(6) Personnel safety in solid waste processing

ATC FORM AUG 72 770

BODY (105 Min)

PRESENTATION:

1a. Given a list of various types of solid waste and three waste classifications (garbage, debris, and rubbish), list each solid waste type under its correct classification.

(1) Purpose of solid waste processing

(a) Prevent breeding of pests

(b) Prevent creation of fire hazards

(c) Prevent unsightly appearances

(d) Prevent odor nuisances

(2) Personnel responsible for solid waste processing

  - (a) Installation commander
  - (b) Installation engineer
  - (c) Sanitation superintendent
  - (d) Solid waste personnel

(3) Classes of solid waste

  - (a) Garbage
  - (b) Debris
  - (c) Rubbish

(4) Edible and nonedible garbage

(a) Edible garbage

1 Vegetable trimmings

2 Meat trimmings

3 Spoiled foods

4 Kitchen leftovers

(b) Nonedible garbage

1 Coffee grounds

2 Tea leaves

3 Fish heads and fins

4 Chicken heads and feathers

(5) Incinerable and nonincinerable debris and rubbish

(a) Incinerable debris

1 Construction wastes

2 Manure

3 Tree trimmings

4 Hay and straw

5 Grass cuttings

(b) Nonincinerable debris

1 Ashes

2 Street sweepings

3 Concrete

4 Glass

(c) Incinerable rubbish

1 Paper

2 Boxes

3 Scrap rubber

4 Bones

(d) Nonincinerable rubbish

1 Bottles

2 Scrap metal

3 Grease

4 Tar products

(6) Personnel safety in solid waste processing

(a) Collection of heavy refuse must be accomplished by at least two men

(b) All personnel must be able to perform strenuous duties

(c) Protective clothing and equipment

1 Leather protective gloves

2 Safety toe shoes

3 Goggles where necessary

APPLICATION:

1. Have students to accomplish WB 3ABR56330-VII-1-P1

2. Check students performance

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT
NONE

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Duties of Solid Waste Monitor (Day 56)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
1 Hr	0	1 Hr

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
49	6 Jun 75	2

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-2 WB VII-2-P1 AFM 91-11

CRITERION OBJECTIVES AND TEACHING STEPS

2a. From provided information, list the duties of the solid waste monitor.

(1) Discarding units

(2) Collection procedures

(3) Collection equipment

(4) Disposal areas

(5) Safety, health, and nuisance precautions

ATC FORM AUG 72 770

BODY (50 Min)

PRESENTATION:

2a. From provided information, list the duties of the solid waste monitor

(1) Discarding units

(a) Must be proper segregation of materials.

1 Garbage

2 Glass

3 Wood, etc.

(b) Keep area around pick up point clean

(c) Keep cans washed and clean

(c) Make sure correct equipment is being used.

(4) Disposal areas

(a) Incinerators

1 Unregulated deliveries interferes with the orderly operation

2 Schedule deliveries at staggered times

3 Delivery of materials to the disposal facility is controlled by the Civil Engineer.

(b) Sanitary landfill

1 Easier to operate and maintain

2 All unscheduled collections should be delivered to landfill not incinerator

(2) Collection procedures

(a) Garbage should be collected daily except Sunday

(b) Rubbish and debris, a max. of 2 times per week

(c) When containers are used for both garbage and debris, it should be picked up twice weekly or as required.

(d) Family housing twice weekly

(3) Collection equipment

(a) An important factor in efficient collection is the use of trucks designed for solid waste being collected

(b) Consideration must be given to amount and type of refuse to be collected

(c) Special collections for salable materials

(5) Safety, health and nuisance precautions

(a) Observe safety when handling heavy cans

(b) Health hazards

(c) Nuisance precautions

1 Ashes and dust

2 Flies and other insects

APPLICATION:

1. Have students to accomplish WB3ABR56330- VII-2-P1
2. Check students performance

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increases effectiveness.

CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

NONE

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Solid Waste Collection Planning and Procedures (Days 56 and 57)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	0	6 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
50	6 Jun 75	3

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-3 WB VII-3-P1 AFM 91-11 AFR 127-101 Base Map FLC 9-251 FLC 20-173

CRITERION OBJECTIVES AND TEACHING STEPS

3a. Provided information from AFM 91-11, list the factors to be considered when planning collection activities.

(1) Quantity and kinds of refuse

(2) Type of disposal

(3) Equipment

(4) Pick up points

(5) Routing of collection vehicles

ATC FORM AUG 73 770

3b. Using AFM 91-11 and AFR 127-101, establish a set of safety precautions to be observed during collection operations of solid waste.

(1) Personnel responsibilities

(2) Protective clothing

(3) Operation of equipment

3c. Using AFM 91-11 and following written instructions, determine the best locations for solid waste pickup stations, and types of storage containers.

(1) Solid waste pickup stations

(2) Refuse receptacles

3d. Using AFM 91-11, list the frequency of collection of garbage, rubbish, and debris for separate collections and combined collection.

(1) Separate collection

(2) Combined collection

3e. Given a base map which shows solid waste pickup stations and location of the sanitary fill, lay out the most feasible route for collecting solid waste.

(1) Type of vehicles

(2) Quantity of refuse

(3) Route selection factors

3f. Given AFM 91-11 and a list of various types of collecting vehicles, pickup stations, and number of pickups per day, determine the number of personnel required to perform supervisory responsibilities and driver, loader, and helper responsibilities.

(1) Supervisor responsibility

(2) Driver responsibility

(3) Loader and helper responsibility

COURSE NO: 3ABR56330
DAY 56 & 57

BRANCH APPROVAL: Bobby Littlejohn
DATE: 21 Aug 75

PART II
INTRODUCTION (10 Min)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (340 Min)

PRESENTATION:

3a. Provided information from AFM 91-11 list the factors to be considered when planning collection activities.

(1) Quantity and kinds of refuse

(2) Type of disposal

  - (a) Sanitary fill
  - (b) Incineration

(3) Equipment

  - (a) Type
  - (b) Design

(4) Pick up points

  - (a) Responsibility
  - (b) Operation

(5) Routing of collection vehicles

(a) Starting points

(b) Distance

(c) Combined

(d) Segregated

3b. Using AFM 91-11 and AFR 127-101, establish a set of safety precautions to be observed during collection operations of solid waste

(1) Personnel responsibilities

(a) Supervisor

(b) Foreman

(c) Driver

(d) Loader

(2) Protective clothing

  (a) Aprons

  (b) Steel toe shoes

  (c) Gloves

  (d) Face shields (optional)

(3) Operation of equipment

  (a) Accident Prevention

  (b) Safe Design

    1 Repair unsafe equipment as soon as possible

    2 Make regular safety inspection of all equipment

3c. Using AFM 91-11 and following written instruction, determine the best locations for solid waste pickup stations, and types of storage containers.

(1) Solid waste pickup stations

(a) Pickup stations are established by the base civil engineer.

(b) Refuse awaiting collection is a potential fire risk.

(c) Traffic conditions are another potential hazard

(d) A separate pickup station for

1 Each dining facility

2 Exchange

3 Club

4 Warehouse or similar building

(e) Pickup station not more than 300 ft. from source of waste

(f) One station serves three to five barracks

(g) Family residence, usually a separate pickup point

(h) Multi-family dwellings, one or more large containers per building

(i) Special provisions must be made for waste generated by maintenance repair, and industrial areas.

(2) Refuse receptacles

(a) Base civil engineer determines capacity and number of containers to be made available

(b) Galvanized trash and garbage cans

(c) Large portable box container

(d) Stationary compactors

(e) Paper bag refuse container

APPLICATION: Have students to complete WB 3ABR56330-VII-3-P1

CONCLUSION DAY 56

SUMMARY:

STUDY ASSIGNMENT:

1. Read SG 3ABR56330-VII-4 and answer its questions
2. Review SG 3ABR56330-VII-3 and its questions

INTRODUCTION DAY 57

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION:

3d. Using AFM 91-11, list the frequency of collection of garbage, rubbish, and debris for separate collections and combined collection.

(1) Separate collection

(a) Determined by segregation requirements

(b) Explain segregation procedures for separate collections

(2) Combined collections

(a) Advantages of efficiency and economy over separate collections

(b) Reduces refuse handling and truck trips

(c) Permits maximum utilization of newer collection equipment such as compaction and multiple container trucks

(d) Practical where sanitary fill is used for method of disposal

(e) Utilized where production of salvageable or salable material is small

3e. Given a base map which shows solid waste pickup stations and location of the sanitary fill, lay out the most feasible route for collecting the solid waste.

(1) Type of vehicles

(a) Loader packers

(b) Dempster Dumpsters

(c) Front Loader-compactors

(2) Quantity of refuse

(a) Compactable

(b) Salvageable

(c) Recycleable

(d) Burnable

(3) Route selection factors

(a) Criterion for establishing refuse collection routes

1 Time and direction

2 Exposure to motor vehicle traffic

3 Shorter hauls at maximum truck carrying capacity

4 Determine the effect on collection Routes of dead-ends, and one-way streets.

5 Try to avoid pickup stations on streets with steep grades

6 Always use secondary or less traveled roads when possible

(b) Procedures for collection route operation

1 Collections should be started from points farthest from disposal area

2 Any steep grades should be covered at beginning of route.

3 Use proper truck for waste to be handled

3f. Given AFM 91-11 and a list of various types of collecting vehicles, pickup stations, and number of pick ups per day, determine the number of personnel required to perform supervisory responsibilities and driver, loader, and helper responsibilities.

(1) Supervisor responsibility

(a) Supervises collection crews

(b) Safety of personel

(c) Efficiency and economy of collection system

(d) Makes periodic adjustments to handle demands

(2) Driver responsibility

- (a) Act as foreman to collection crew
- (b) Safe operation of his vehicle
- (c) Follow correct routes
- (d) Keep materials segregated
- (e) Report discrepancies in segregation practices at pickup stations

(3) Loader and helper responsibility

- (a) Safe operating practices
- (b) Know segregation requirements
- (c) Notify driver of improper segregation of waste

(d) Clean up spilled garbage immediately

APPLICATION: Using map provided, lay out a collection route, frequency of collection, type of collection equipment to be used and the number of personnel required to perform supervisory, driver, loader, and helper responsibilities.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT

NONE

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Solid Waste Collection and Transportation (Day 57)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
3 Hrs	0	3 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
51	6 Jun 75	4

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-4 WB VII-4-P1 AFM 91-11 MP 67-5

CRITERION OBJECTIVES AND TEACHING STEPS

4a. Given AFM 91-11, list the four common types of collection equipment.

(1) General purpose trucks

(2) Specialized refuse collection vehicles

ATC FORM AUG 72 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

4b. Given AFM 91-11 and various problems containing one or more of the known factors in solid waste collection and disposal procedures, select the best suited equipment to accomplish the job.

(1) Characteristics of vehicles

(2) Limitations of vehicles

4c. Given AFM 91-11, list the rules for proper utilization, operation, and care of collection equipment.

(1) Proper utilization

(2) Operation

(3) Care of collection equipment

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COURSE NO. 3ABR56330 BRANCH APPROVAL: Bobby Littlejohn
DAY 57 DATE: 21 Aug 75

PART II
INTRODUCTION (10 Min)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (160 Min)

PRESENTATION:

4a. Given AFM 91-11, list the four common types of collection equipment.

(1) General purpose trucks

(a) Flat bed trucks

(b) Dump trucks

(c) Semitrailer trucks

(2) Specialized refuse collection vehicles

(a) Rear hopper compaction

(b) Container hoisting/compaction

(c) Container hoist-and-carry

4b. Given AFM 91-11 and various problems containing one or more of the known factors in solid waste collection and disposal procedure, select the equipment best suited to accomplish the job.

(1) Characteristics of vehicles-
Refer to AFM 91-11 pages 2-4
then 2-5

(2) Limitations of vehicles-
Refer to AFM 91-11 page 3-3

4c. Given AFM 91-11, list the rules for proper utilization, operation, and care of collection equipment.

(1) Proper utilization

(a) General purpose trucks

(b) Specialized collection vehicles

(2) Operation

(a) Specific Practices

(b) General practices

(3) Care of collection equipment

(a) Operator's inspection

(b) Cleaning of equipment

APPLICATION:

Accomplish WB VII-4-1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY

Cover main points of lesson

REMOTIVATION:

STUDY ASSIGNMENT:

Read SG 3ABR56330-VII-5

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE

Solid Waste Disposal Methods and Their Operation (Days 58 and 59)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
12 Hrs	0	12 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
52	6 Jun 75	5

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-5 WB VII-5-P1 AFM 91-11 Slides MK 1-5

CRITERION OBJECTIVES AND TEACHING STEPS

5a. Given AFM 91-11, list the methods and operating principles of a sanitary landfill.

(1) Types of landfills

(2) Trench method

(3) Area method

(4) Advantages and disadvantages of landfills

5b. Given AFM 91-11, list the items to observe to determine the correct utilization of earth moving equipment.

(1) Specific practices

(2) General practices

ATC FORM AUG 73 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

5c. Given AFM 91-11, list the standards and operating principles of incinerators.

(1) Standards

(2) Operating principles

5d. Given AFM 91-11, list the items to observe when determining the correct utilization of incinerators.

(1) Flammable materials

(2) Fire extinguishers

(3) Guardrails

(4) Face masks

(5) Safety valves

(6) Electrical equipment

5e. After observing the equipment and operating procedure utilized by a sanitary landfill, name the equipment and safety precautions observed.

(1) Proper use of equipment

(2) Safety equipment and precautions

Course NO: 3ABR56330
Days 58 & 59

Branch Approval: Billy Littlejohn
Date: 21 Aug 75

PART II

INTRODUCTION (10 Min)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (700 Min)

PRESENTATION:

5a. Given AFM 91-11, list the methods and operating principles of a sanitary landfill.

(1) Types of landfills

- (a) Trench

- (b) Area

(2) Trench method

- (a) Also known as cut and cover

- (b) Trenches are excavated below the original ground surface

- (c) Especially wall suited to level terrain

- (d) Generally preferred over the area method.

- (e) Method of operation

1 Dig trench below original ground surface

2 Dump refuse into short section of trench

3 Spread and compact refuse

4 Cover the compacted refuse daily with 6 inches of soil

(3) Area Method

(a) Best applied to rolling, uneven terrain

(b) Conditions under which this method can be used

1 Pit, hole or sidehill

2 Flat land

3 Ravines or gullies

(c) Method of operation

1 Prepare slope of 30 degrees if using pit, hole, sidehill or flat land

2 Deposit refuse in base of depression and thoroughly compact if using ravines or gully

3 Cover daily with 6-inch layer of dirt

4 Final cover will be 2ft of clean earth

(4) Advantages and disadvantages of landfills

(a) Adavantages

1 Can be put into operation in a few days

2 Over all cost is small

3 Does not require a large crew for operation

4 Makes it practical to dispose of combined refuse

5 Permanent means of disposal

6 Converts waste land into usable areas

(b) Disadvantages

1 Frozen ground in winter

2 Soil too loose allowing leaching which causes pollution of ground and surface water

3 Groundwater table near the surface

4 Access for refuse vehicles during inclement weather

5 Sufficient disposal area

6 Away from inhabited building and down wind

5b. Given AFM 91-11, list the items to observe to determine the correct utilization of earth moving equipment.

(1) Specific practices- for complete instructions on the various types of equipment, consult manufacturer's handbook

(2) General practices

(a) Avoid excess tractor travel

(b) Govern the depth of cutting with a bullclam by opening or closing the lip of the bucket

(c) Raise or lower the bullclam blade by means of the hydraulic control lever

(d) When the bullclam is filled, close the lip and float the load on top of the ground so the load is not carried by the tractor

(e) Before moving or filling the bucket of a front-end loader, set the shoe on or close to the ground. Set bucket for proper cut.

(f) Fill bucket on front-end loader, roll the bucket back all the way. Lift shoes so the load can be semiskidded over the ground

(g) Always roll the front-end loader bucket all the way back when transporting

(h) Never perform maintenance on equipment while it is in operation

5c. Given AFM 91-11, list the standards and operating principles of incinerators

(1) Standards

(a) If built after 6 June 1966

(b) If built before 6 June 1966

(2) Operating principles

(a) Types of incinerators

1 Barrel arch

2 Charging hood

3 Medical

(b) Operating temperatures

(c) Capacity

(d) More expensive to operate than landfill

(e) Requires segregation of refuse

5d. Given AFM 91-11, list the items to observe when determining the correct utilization of incinerators.

(1) Flammable materials

(2) Fire extinguishers

(3) Guardrails

(4) Face masks

(5) Safety valves

(6) Electrical equipment

APPLICATION:

Student will list the items to observe when determining the correct utilization of incinerators, earth moving equipment

Complete WB 3ABR56330-VII-5-P1

CONCLUSION Day 58

SUMMARY:

STUDY ASSIGNMENT

Review SG 3ABR56330-VII-5

INTRODUCTION DAY 59

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION:

5e. After observing the equipment and operating procedure utilized by base sanitary landfill, name the equipment and safety precautions observed.

(1) Proper use of equipment

(a) Types

(b) Personnel

(c) Operation

(2) Safety equipment and precautions

(a) Directing moving equipment

(b) Safety practices during operations

APPLICATION:

Have students to name the equipment and safety precautions after observing the equipment and operating procedures utilized by base sanitary landfill.

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

Cover main points of lesson and answer student questions.

REMOTIVATION:

Reemphasize why student needs to remember and apply what he has learned

STUDY ASSIGNMENT:

Read the following:
SG 3ABR56330-VII-6

SG 3ABR56330-VII-7

SG 3ABR56330-VII-8

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	**INSTRUCTOR**
COURSE NUMBER 3ABR56330	**COURSE TITLE** Environmental Support Specialist
BLOCK NUMBER VII	**BLOCK TITLE** Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Sanitation in Solid Waste Processing (Day 60)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
1 Hr	0	1 Hr

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
53	6 Jun 75	6

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-6 WB VII-6-P1 AFM 91-11

CRITERION OBJECTIVES AND TEACHING STEPS

6a. Provided information, list the sanitation practices to be observed by all activities related to the collection, transportation, and disposal of solid wastes.

(1) Sanitation practices for discarding units

(2) Sanitation practices for collection units

(3) Sanitation items that should be coordinated with base medical services

(4) Correct procedures for covering daily layers of compacted refuse

ATC FORM AUG 72 770

COURSE NO: 3ABR56330 BRANCH APPROVAL: Billy Littlejohn
DAY 60 DATE: 22 Aug 75

PART II

INTRODUCTION (5 Min)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (50 Min)

PRESENTATION:

6a. Provided information, list the sanitation practices to be observed by all activities related to the collection, transportation, and disposal of solid wastes.

(1) Sanitation practices for discarding units

(a) Discarding units are required to keep receptacles, stands and area around containers clean

(b) Discarding units must sort and deliver refuse to pick up stations

(2) Sanitation practices for collection units

(a) Collection crews are responsible for keeping trucks and mobile containers clean

(b) Cleaning stations with hot water or steam should be on or near route

(c) Clean at end of operation daily

(3) Sanitation items that should be coordinated with base medical services

(a) Special incinerators are required for hospital waste

1 Human waste

2 Animal waste

3 Operating room waste

4 Bandages

(b) This type of waste must not be disposed of in sanitary fill

(4) Correct procedures for covering daily layers of compacted refuse

(a) Refuse should be completely covered and compacted at the end of each day

(b) Do not leave refuse exposed

(c) Concrete waste and scrap lumber should not be placed near surface

  1 Allows possible rat harborage

  2 May create odor problems

(d) Two feet of cover for final cover

  1 Six inches for sealing cell at end of day

  2 Allow six inches for settling in first few weeks

APPLICATION:

Have student accomplish
WB 3ABR56330-VII-6-P1

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

Cover main point of lesson and student questions

REMOTIVATION:

Reemphasize why student needs to remember and apply what he has learned

STUDY ASSIGNMENT:
NONE

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/17Jun75	INSTRUCTOR
COURSE NUMBER 3ABR56330	COURSE TITLE Environmental Support Specialist
BLOCK NUMBER VII	BLOCK TITLE Collection, Transportation, and Disposal of Solid Waste

LESSON TITLE
Public Health and Nuisance Aspects (Day 60)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
1 Hr	0	1 Hr

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
53	6 Jun 75	7

STS/CTS REFERENCE

NUMBER	DATE
563X0	28 July 1971

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
None	None	None	SG VII-7 WB VII-7-P1 AFM 91-11

CRITERION OBJECTIVES AND TEACHING STEPS

7a. Using AFM 91-11, list the items that would be a health hazard or a nuisance to personnel operating a solid waste disposal system.

(1) Insects

(2) Hazardous wastes

(3) High water table

(4) Dust and odors

(5) Blowing paper

7b. Using information provided, list the disposal activities which will be coordinated with base medical services.

(1) Operating medical incinerator

(2) Disposal of hospital wastes

ATC FORM AUG 72 770

COURSE NO: 3ABR56330 BRANCH APPROVAL: Bobby Littlejohn
DAY 60 DATE: 22 Aug 75

PART II
INTRODUCTION (5 Min)

CHECK PREVIOUS DAYS STUDY ASSIGNMET

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (50 Min)

PRESENTATION:

7a. Using AFM 91-11, list the items that would be a health hazard or a nuisance to personnel operating a solid waste disposal system.

(1) Insects

(a) Flies

1 Carry diseases

2 Bothersome

(b) Mosquitoes

1 No standing water

2 Periodic spraying for control

(2) Hazardous wastes

(a) Toxic

(b) Infectious

(c) Combustible

(3) High water table

(a) Mobility of equipment

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(b) Flotation of Refuse

(4) Dust and odors

(a) Use pressurized water

(b) Water truck if pressurized water not available

(5) Blowing paper

7b. Using information provided, list the disposal activities which will be coordinated with base medical services.

(1) Operating medical incinerator

(2) Disposal of hospital waste

APPLICATION: Have students to complete WB 3ABR56330-VII-7-P1

EVALUATION:

Evaluate by oral or written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Min)

SUMMARY:

Cover main points of lesson and students questions.

REMOTIVATION:

Reemphasize why student needs to remember and apply what he has learned

STUDY ASSIGNMENT:

NONE

11-7 311

PREPARE THE MAN

STUDY GUIDE 3ABR56330-VII-1 thru 8

Department of Civil Engineering Training

Engineer Environmental Support Specialist

COLLECTION, TRANSPORTATION AND DISPOSAL OF SOLID WASTES

16 August 1971

SHEPPARD AIR FORCE BASE, TEXAS

Designed For ATC Course Use

DO NOT USE ON THE JOB

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PURPOSE OF STUDY GUIDES AND WORKBOOKS

Study Guides and Workbooks are training publications authorized by Air Training Command (ATC) for student use in ATC courses.

The STUDY GUIDE (SG) presents the information you need to complete the unit of instruction, or makes assignments for you to read in other publications which contain the required information.

The WORKBOOK (WB) contains work procedures designed to help you achieve the learning objectives of the unit of instruction. Knowledge acquired from using the study guide will help you perform the missions or exercises, solve the problems, or answer questions presented in the workbook.

The STUDY GUIDE AND WORKBOOK (SG/WB) contains both SG and WB material under one cover. The two training publications may be combined when the WB is not designed for you to write in, or when both SG and WB are issued for you to keep.

SGs and WBs are designed for ATC course use only. They are updated as necessary for training purposes, but are NOT to be used on the job as authoritative references in preference to Technical Orders or other official publications.

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COLLECTION, TRANSPORTATION AND DISPOSAL OF SOLID WASTE

Days 56 - 60

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Dept of Civil Engineering Tng
Sheppard AFB, Texas

SG 3ABR56330-VII-1
16 August 1971

INTRODUCTION TO SOLID WASTE PROCESSING

OBJECTIVE

Upon completing this unit of instruction you will be familiar with definition, classification, description, segregation and methods of refuse disposal.

INTRODUCTION

In order for the solid waste monitor to properly manage a collection system, he must first be able to define the different types of refuse and the different types of pickup stations. The monitor must also be able to determine the best method of disposal.

STUDY ASSIGNMENT

AFM 85-11, Refuse Collection and Disposal, Part A, Section 1 General, A1.01
Purpose and Scope - A1.02
Responsibility - A1.03
Definitions - A1.04 Classification of Refuse.

QUESTIONS

1. What is refuse?

2. What is rubbish?

3. What would be considered salvage or salable materials?

4. What is a sanitary fill?

5. How are medical wastes disposed of?

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DUTIES OF A SOLID WASTE MONITOR

OBJECTIVE

Upon completing this unit of instruction you will be familiar with the duties of a solid waste monitor.

INTRODUCTION

On some bases solid waste disposal functions are performed by Air Force personnel, on other bases these duties are performed by a contractor. In any case, a solid waste disposal monitor would be assigned to make sure the task is completed in the proper manner.

DUTIES OF A SOLID WASTE DISPOSAL MONITOR

Monitors solid waste collection, transportation, and disposal processing facilities. Monitors discarding units for proper segregation of materials such as combustible trash, metals, glass, paper, wood, salvageable materials and ashes. Monitors the collection and transportation of combustible and noncombustible solid waste from pickup stations to points of disposal. Posts operating records daily for each collection vehicle indicating type of material collected and total cubic yards delivered to place of disposal. Coordinates with base medical service on procedures for radioactive waste disposal. Plans collection routes, controls deliveries to disposal facilities and expedites unloading operation for economics and safety. Maintains material inventory at disposal points for metals, paper, wood, and other reusable wastes. Monitors operations for efficient utilization of mechanized equipment.

QUESTIONS

1. Name the monitoring duties of discarding units.
2. List the monitoring responsibilities involved in the collection procedure.
3. Would the monitor of the collection equipment overhaul the equipment?
4. List the monitoring duties of the disposal areas.

REFERENCES

AFM 39-1, Airman Classification Manual

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SOLID WASTE COLLECTION AND TRANSPORTATION EQUIPMENT

OBJECTIVES

The purpose of this study guide is to aid you in learning the different types of solid waste collecting and transporting equipment.

INTRODUCTION

Collection equipment must be carefully selected and placed conveniently. The size and type of equipment must be selected to fit the job. Vehicles are then selected to fit the job to be performed. The complete system must then be supervised to conserve manpower and money.

STUDY ASSIGNMENT

AFM 85-11, Part B, Refuse Collection Section 2, Collection Equipment.
B2.01 General.
B2.02 General Purpose Trucks.
B2.03 Semitrailers.
B2.04 Special Collection Bodies.
B2.05 Multiple Container Trucks.
B2.06 Correct Operation of Collection Equipment.

QUESTIONS

1. What should be taken into consideration when selecting solid waste equipment for an installation?

2. Where are semitrailers used in a solid waste collection system?

3. How much does a built-in compaction mechanism normally reduce the volume of compressible materials?

4. The bodies on bucket loaders can usually contain from __________ to __________ cubic yards of refuse.

5. What type of system is used to raise and lower collection bodies on solid waste collection equipment?

SOLID WASTE DISPOSAL METHODS AND THEIR OPERATION

OBJECTIVE

The purpose of this study guide is to aid you in learning solid waste disposal methods and how these facilities operate.

INTRODUCTION

Solid waste disposal methods have become increasingly important in the past few years. Properly disposed of, solid waste will not create any problems from a sanitary standpoint. A solid waste disposal area that is not properly managed and operated will create hazards from disease bearing rodents and insects and create the nuisance of sight and smell. The land used to dispose of solid waste cannot be reused if proper sanitary land fill methods have not been followed.

STUDY ASSIGNMENT

1. AFM 85-11, Part C, Disposal Methods; Section 1, General
   C1-01 Methods.
   C1.02 Weight Factors

2. AFM 85-11, Section 2, Sanitary Fill.
   C2.01 General.
   C2.02 Sight Selection.
   C2.03 Method of Operation.
   C2.04 Construction Requirements for Trench Method.
   C2.05 Operating Personnel.
   C2.06 Equipment Application.
   C2.07 Correct Operation of Earth Moving Equipment.
   C2.08 Section of Trench.
   C2.09 Operating the Fill.
   C2.10 Low Temperature Operation.
   C2.11 General Practices.
   C2-12 Correct Operation of Sanitary Fill.

3. AFM 85-11, Section 4, Incineration.
   C4.01 Emission Visibility Standards for Incinerators.
   C4.02 Site Selection.
   C4.03 Safety Measures.
   C4.04 Charts, Signs, and Records
   C4.05 Tools.
   C4.06 Personnel Requirements and Labor Schedules.
   C4.07 Incinerator Capacity.
   C4.08 Temperature Range

C4.09 Materials Unsuitable for Incineration.
C4.10 Placing Incinerators in Service.
C4.11 Taking Incinerators Out of Service.
C4.12 Types of Incinerators.
C4.13 Barrel Arch Incinerators.
C4.14 Charging Hood Incinerators.
C4.15 Medical Incinerators

QUESTIONS

1. What does the term "urban area" mean in relation to equivalent population?
2. Name some of the advantages of a sanitary land fill.
3. What type of waste may not be disposed of in a sanitary land fill?
4. What are some considerations when selecting a location for a sanitary land fill?
5. What are bumper logs used for at the sanitary land fill?
6. How often should the refuse pile be sealed?
7. What is the purpose of portable fences at the sanitary land fill?
8. How is the barrel arch incinerator burning capacity rated?

SANITATION IN SOLID WASTE PROCESSING

OBJECTIVE

Upon completing this unit of instruction, you will be familiar with the sanitation aspects in solid waste processing.

INTRODUCTION

Good sanitation practices must be followed in the storage collection and disposal of solid waste. The discarding units as well as the collection and disposal crews must be alert so that no health hazard is allowed to develop. Flies and other vector must not become a nuisance at the collection or disposal points.

STUDY ASSIGNMENT

AFM 85-11, Part A, Introduction; Section 2, Sanitation; A2.01 through A2.05.

QUESTIONS

1. Who has the responsibility of keeping the area around the receptacle stands clean?
2. Where are receptacle stands located?
3. How is the size of a receptacle stand determined?
4. How high should the top surface of a receptacle be from the ground surface?
5. How often should garbage cans be washed?
6. If there are no central can washing facilities, who is responsible for washing the cans?
7. How often should the inside of collection trucks and containers be washed?

PUBLIC HEALTH AND NUISANCE ASPECTS

OBJECTIVE

The purpose of this study guide is to aid you in learning the public health and nuisance aspects of solid waste collection and disposal.

INTRODUCTION

Public health and nuisance aspects must be known before any attempt is made to dispose of solid waste. Vector control must be closely supervised. The site must be selected and managed so that no water pollution occurs. Air pollution, dust and odors must be closely controlled. Air pollution is one of the big factors governing incinerator operations.

Public health and nuisance aspects will be discussed under the following main headings.

- METHODS OF VECTOR CONTROL
- PRECAUTIONS AGAINST WATER POLLUTION
- REDUCTION OF AIR POLLUTION
- CONTROLS FOR DUST AND ODORS
- HEALTH AND NUISANCE ASPECTS COORDINATED WITH BASE MEDICAL SERVICES

METHODS OF VECTOR CONTROL

Vector control is not a major problem at a sanitary land fill that is operated correctly. However, there are some precautions that must be taken. During the summer months the compacted waste may be sprayed to retard the fly population. No water should be allowed to stand in the area of a sanitary land fill. After the trench is sealed checks must be made for rat burrows and the area resealed if any are found.

PRECAUTIONS AGAINST WATER POLLUTION

High water tables may cause many operational difficulties, such as inability to properly compact the refuse; the flotation of refuse; and places limitation upon the mobility and usefulness of land fill and collection equipment. Water pollution may be caused by direct horizontal or vertical leaching as a result of chemical contaminants, biological contaminants, and the decomposition of products placed in the sanitary land fill. A site having a high water table may be used if only that portion of the site above the water table is used. Two to five feet above known high water is recommended as a minimum. For this type operation, cover material may be obtained on site above the water table or by hauling from another location. You may permanently lower the water table with underground drains or drainage ditches. You could temporarily lower the

4. How may high water tables permanently be lowered so sanitary land fill operations can be used?

5. What are the emission standards for incinerators based on?

6. How is dust controlled at the sanitary land fill?

7. How is blowing paper controlled at the sanitary land fill?

MODIFICATIONS

Pages 17-18 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

WORKBOOKS 3ABR56330-VII-1-P1 thru 5-P1

WORKBOOK 3ABR56330-VII-8-P1

Department of Civil Engineering Training

Environmental Support Specialist

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COLLECTION, TRANSPORTATION, AND DISPOSAL OF SOLID WASTES

April 1975

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

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This supersedes WBs 3ABR56330-VII-1-P1 thru 8-P1, 16 August 1971, and WB 3ABR56330-VII-2-P1, 2 December 1974.

Dept of Civil Engineering Tng
Sheppard AFB, Texas

WB 3ABR56330-VII-1-P1
April 1975

INTRODUCTION TO SOLID WASTE PROCESSING

OBJECTIVE

The purpose of this exercise is to aid you in learning solid waste processing.

INSTRUCTIONS

Given AFM 91-11, answer the following questions:

1. Who is responsible for carrying out refuse collection and disposal procedures? REFERENCE: Para (1-2)

____

____

____

2. What two agencies prescribe safety and health standards for refuse collection and disposal procedures? REFERENCE: (1-1 a)

____

____

3. Define the following terms. REFERENCE: (Attachment 1)

   a. Refuse ______________________________

   ____

   ____

   b. Garbage ______________________________

   ____

   ____

   c. Debris ______________________________

   ____

   ____

   d. Salvage or salable materials ______________________________

   ____

e. Solid waste management ______________________________

____

____

f. Furnace ______________________________________

____

____

g. Grate _______________________________________

____

____

h. Mixing chamber ________________________________

____

____

i. Charging chute _________________________________

____

____

WB 3ABR56330-VII-2-P1
April 1975

DUTIES OF A SOLID WASTE MONITOR

OBJECTIVE

The purpose of this exercise is to aid you in learning the duties of a solid waste monitor.

INSTRUCTIONS

Given information in Study Guide VII-2, answer the following questions.

1. What types of materials should be segregated by the discarding unit?

2. What information must be posted on the daily record for each collection vehicle?

3. What must you do before disposing of radioactive waste?

4. What information must be on the inventory of material at the disposal site?

5. List the monitoring responsibilities involved in the collection procedures.

6. Would the monitor of the collection equipment repair the equipment? Why?

7. List the monitoring duties performed at the disposal areas.

8. Summarize the duties of the solid waste monitor in your own words.

SOLID WASTE COLLECTION PLANNING AND PROCEDURES

OBJECTIVE

The purpose of this exercise is to aid you in learning the solid waste collections, planning and procedures associated with all solid waste collection and disposal systems.

INSTRUCTIONS

Given AFM 91-11, answer the following questions.

1. What device is used to locate pickup stations in relation to sources of waste and to the disposal area? REFERENCE (2-10 a)

2. What type of collection reduces handling, truck trips, and permits maximum use of special collection vehicles? REFERENCE (2-9 c)

3. What manual is used as a guide for refuse contract action? REFERENCE (2-11)

4. Why should hand unloading be avoided? REFERENCE (2-13 a)

5. How many barracks buildings are usually served by one pickup station? REFERENCE (2-8 d)

6. **How much will uncompacted solid waste from family housing normally weigh per cubic yard? REFERENCE (2-4 c (2))**

7. **Who selects the collection system best suited for local needs and resources? REFERENCE (2-1)**

8. **How often should general refuse be scheduled for pickup? REFERENCE (2-9a(1))**

9. **Why are refuse trucks scheduled to start collections at points farthest from the disposal area? REFERENCE (2-10 c)**

10. **Are the loaders on a waste disposal collection vehicle required to segregate materials at their pickup points? Explain. REFERENCE (2-12 b(3))**

SOLID WASTE COLLECTION AND TRANSPORTATION EQUIPMENT

OBJECTIVE

The purpose of this exercise is to aid you in learning solid waste collection and transportation equipment and some of the cautions that must be observed when operating this equipment.

INSTRUCTIONS

Given AFM 91-11, answer the following questions.

1. In collecting refuse where would semitrailers normally be used? REFERENCE (2-7 b)

____

____

____

2. What are some of the advantages of special collection bodies used for collection and transportation of refuse? REFERENCE (2-7 c)

____

____

____

____

3. Compaction type truck bodies range in capacities from ____________ to ____________ cubic yards. REFERENCE (2-7 c(1))

4. One multiple container hoist and carry truck can usually service from ________ to ________ containers. REFERENCE (2-7 c(2))

5. What type of system is used on collection trucks to raise and lower the bodies? REFERENCE (2-12 c (2)(a))

____

____

____

6. What are some of the precautions that should be observed when loading a detached container on a collection truck? REFERENCE (2-12 c (2)(l))

7. What are some of the precautions that should be observed when operating a power takeoff on a collection truck? REFERENCE (2-12 c (2)(b))

8. Why are bumper logs used at the dump site? REFERENCE (2-12 c(2)(k))

9. When operating a rear loading compaction vehicle, what are some precautions that must be observed? REFERENCE (2-12 c(2)(f) and (g))

10. What kind of container is recommended at the pickup station for storing edible garbage? REFERENCE (2-5 a(7))

11. What kind of container is recommended for storing cooked grease that can be sold? REFERENCE (2-5 a(8))

WB 3ABR56330-VII-5-P1
April 1975

SOLID WASTE DISPOSAL METHODS AND THEIR OPERATION

OBJECTIVE

The purpose of this workbook is to aid you in learning solid waste disposal methods and their operation.

INSTRUCTIONS

Given AFM 91-11, answer the following questions.

1. List some of the advantages of a sanitary landfill over other disposal methods. REFERENCE (3-10)

2. List the items that cannot be placed in a sanitary landfill operation. REFERENCE (3-10)

3. List the desirable terrain features for sanitary landfill operations. REFERENCE (3-12a, b, and c)

4. What type of cover soil is used in the sanitary landfill? REFERENCE (3-14b(1))

5. What are the two methods of operation for a sanitary landfill? REFERENCE (3-14)

____

____

6. List the type of terrain where each method would be used. REFERENCE (3-14 a(1))

____

____

____

____

7. To serve an installation with 8,000 to 10,000 men, how deep should the starting trench in the sanitary fill be? REFERENCE (3-15 c)

____

8. How is blowing paper controlled during dumping operations at the sanitary landfill? REFERENCE (3-21 b)

____

____

9. How often should the surface and face of the fill be sealed? REFERENCE (3-21 f)

____

____

10. How long after closing a fill should the maintenance program be continued? REFERENCE (3-21 k)

____

____